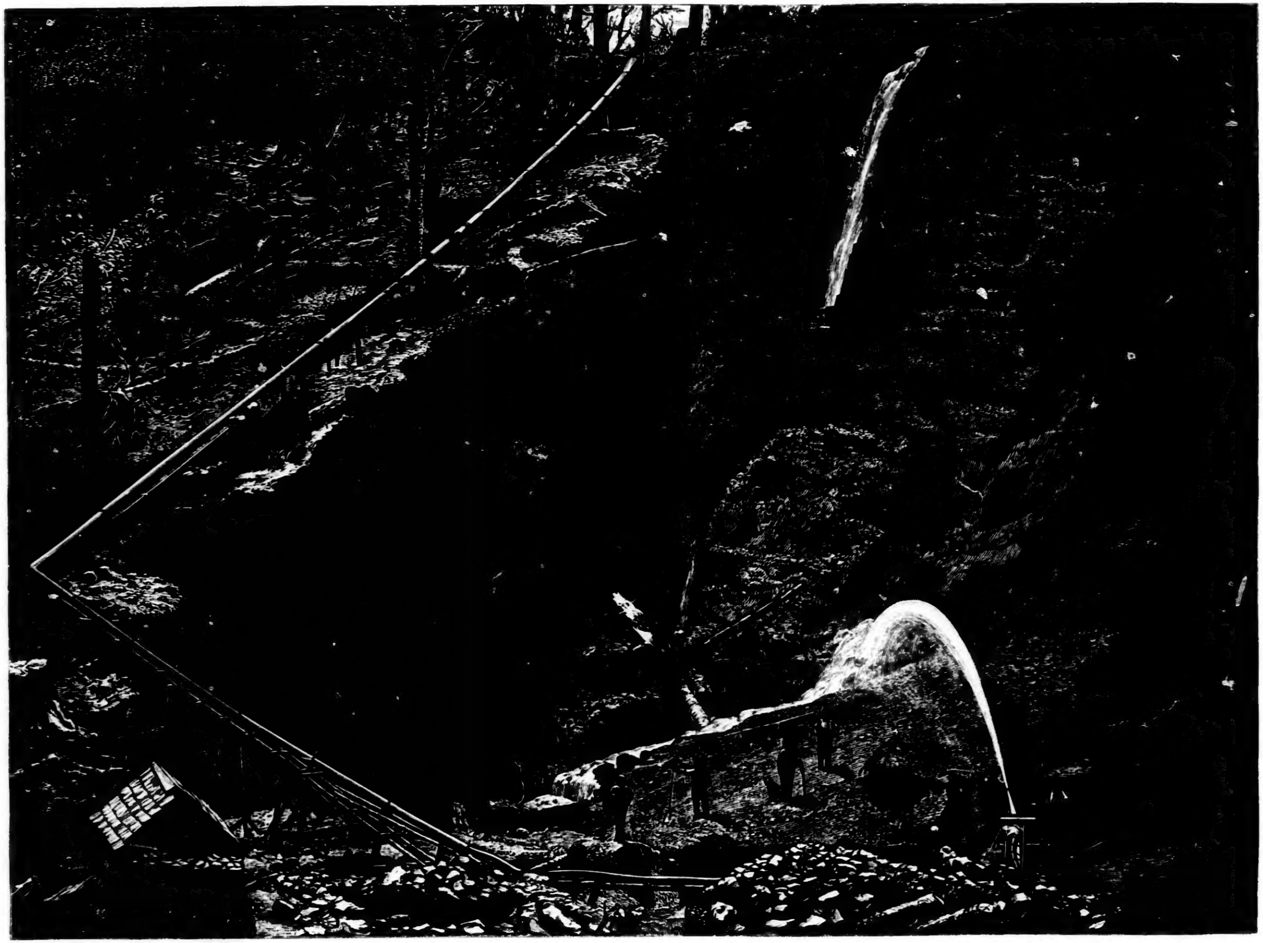

Ground-sluicing at Devil's Creek Reefton, New Zealand.

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GOLD:

ITS OCCURRENCE AND EXTRACTION.

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BY

ALFRED G. LOCK, F.R.G.S.

[illegible]

LONDON:
E. & F. N. SPON, 46, CHARING CROSS.
NEW YORK: 44, MURRAY STREET.
1882.

GOLD:

ITS OCCURRENCE AND EXTRACTION.

EMBRACING

THE GEOGRAPHICAL AND GEOLOGICAL DISTRIBUTION AND
THE MINERALOGICAL CHARACTERS OF
GOLD-BEARING ROCKS;

THE PECULIAR FEATURES AND MODES OF WORKING
SHALLOW PLACERS, RIVERS, AND DEEP LEADS;

HYDRAULICING;

THE REDUCTION AND SEPARATION OF
AURIFEROUS QUARTZ;

THE TREATMENT OF COMPLEX AURIFEROUS ORES CONTAINING
OTHER METALS;

A BIBLIOGRAPHY OF THE SUBJECT;

AND

A GLOSSARY OF ENGLISH AND FOREIGN TECHNICAL TERMS.

BY

ALFRED G. LOCK, F.R.G.S.

WITH SIX DOUBLE-PAGE MAPS, AND 185 ENGRAVINGS IN THE TEXT.

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INTRODUCTION.

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THE possession of gold has been the aim of all races, in all ages, and of all classes of society. The quest of gold has led men to the ends of the earth, and has been the primary inducement in colonizing hitherto

N.B.—The section on Russia is entirely from the pen of E. DELMAR MORGAN, F.R.G.S., the well-known explorer of Central Asia.

conditions under which gold occurs, so that new fields may be opened up to supply the places of those which have been worked out; and they make it the duty of every intelligent miner to avail himself of the experience of others, in endeavouring to reduce the cost of extracting the gold, and especially the loss of metal in conducting his operations, to the lowest possible figures. Recent geological explorations have shown that gold is abundantly present in formations which it was authoritatively stated could never prove to be auriferous, and in the light of our present knowledge it would not be safe to exclude any geological series from the possibility of being gold-bearing. Gold reveals its presence in the earth's crust far less readily than other useful minerals, and many a gold-field has been passed over by generations of men before its riches were discovered. Hence the necessity for intelligent search.

It seemed to the author of this volume that a great step towards aiding the advance of the gold industry would be to bring together in a concentrated form all available existing information on the subject. The

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THE possession of gold has been the aim of all races, in all ages, and of all classes of society. The quest of gold has led men to the ends of the earth, and has been the primary inducement in colonizing hitherto unknown districts. Without the great gold discoveries of the last 30 years, our commerce could not have attained its present vast proportions. The importance of the metal especially to all English-speaking peoples cannot be exaggerated, and every year adds to this importance. On the other hand, the supply shows a waning tendency. The enormous, easily-worked, alluvial deposits of Australia, California, and Siberia, have been exhausted over large areas, though many similar deposits must yet remain undiscovered. In the more difficult operations of extracting gold from mineral veins and complex ores, reliable evidence from all parts of the world shows that most of the processes at present in use, or the methods of carrying them out, are far from satisfactory, as they entail the loss, on the average, of one-quarter to one-third of the gold present in the material operated upon.

These facts point unmistakably to the necessity for studying the conditions under which gold occurs, so that new fields may be opened up to supply the places of those which have been worked out; and they make it the duty of every intelligent miner to avail himself of the experience of others, in endeavouring to reduce the cost of extracting the gold, and especially the loss of metal in conducting his operations, to the lowest possible figures. Recent geological explorations have shown that gold is abundantly present in formations which it was authoritatively stated could never prove to be auriferous, and in the light of our present knowledge it would not be safe to exclude any geological series from the possibility of being gold-bearing. Gold reveals its presence in the earth's crust far less readily than other useful minerals, and many a gold-field has been passed over by generations of men before its riches were discovered. Hence the necessity for intelligent search.

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handsome work written some years ago by John Arthur Phillips, F.R.S., the well-known metallurgist, has long been out of print and very scarce, and many new discoveries and inventions have since been made. Gold-mining too has taken a great start of late, many millions of fresh capital having found employment in this sphere. Hence there would appear to be ample room for an exhaustive book on the subject. How far the present work may fulfil the required conditions must be left to the reader's judgment. The cordial assistance received by the author from all who had knowledge to impart will be evident from a perusal of the following pages.

It remains to pay a tribute of hearty thanks to the many kind contributors mentioned in the following list, from whose labours the book derives whatever value it may have.

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ALFRED G. LOCK.

MERTON LODGE, COWLEY ROAD, BRIXTON.
November 9, 1882.

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In this chapter the world is divided into 6 sections, each illustrated by a map, and the sections are again separated into countries, as indicated on pp. 1–2. In describing, in turn, every country which produces or has produced gold, or is known to possess gold-bearing rocks, attention is given to the exact localities where the metal or rocks exist, to the general geological features of each field, to the characters of the ores, to the native methods employed for extracting the gold, to ancient and modern statistics of the yield, to the laws and regulations affecting the industry, to the cost of necessaries and rate of wages, to the labour question and the climate, to traditions indicating past or hidden sources of wealth, and, in short, to every point which seems to throw any light upon the subject.

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GOLD:

ITS OCCURRENCE AND EXTRACTION.

CHAPTER I.

GEOGRAPHICAL DISTRIBUTION.

An account of the localities where gold or gold-bearing rocks are now known to exist, or where their presence has been alluded to in past history or tradition—in other words, the geographical distribution of gold—will form the first chapter of this volume.

The countries yielding gold in workable quantities can no longer be counted upon the fingers, hence the necessity for arranging them in systematic order. For convenience in proportioning the maps accompanying this chapter, the world is arbitrarily divided into six portions, which will be taken in alphabetical order. Their scope may be readily seen from the following table :—

Africa (Map 1) :—

- Northern
- Southern
- Western

America [North] (Map 2) :—

- Alaska
- British America
- Costa Rica
- Guatemala
- Honduras
- Mexico
- Nicaragua
- United States
- West Indies

America [South] (Map 3) :—

- Argentine Republic
- Bolivia
- Brazil
- Chili
- Colombia (United States of)
- Ecuador
- Guiana (British)
- Guiana (Dutch)
- „ (French)
- Paraguay
- Patagonia
- Peru
- Uruguay
- Venezuela

Asia (Map 4) :—

- Afghanistan
- Anam, Cambodia, Cochin China, and Siam
- Arabia
- Assam
- Banca
- Borneo
- Burma
- Celebes
- Ceylon
- China
- Corea
- India
- Japan
- Kashmir
- Ladak
- Malay Peninsula
- Persia
- Philippines
- Russia in Asia
- Sumatra
- Thibet
- Trans-Caucasus
- Turkestan
- Turkey in Asia

Australasia (Map 5):—

- New Caledonia
- New Guinea
- New South Wales
- New Zealand
- Queensland
- South Australia
- Tasmania
- Timor
- Victoria
- Western Australia

Europe (Map 6) :—

- Austro-Hungary
- France
- Germany
- Greece
- Iceland
- Italy
- Roumania
- Russia in Europe
- Servia
- Spain and Portugal
- Sweden and Norway
- Switzerland
- Turkey in Europe
- United Kingdom

AFRICA.

African geography is in such an unsatisfactory state, and so few African countries possess well-defined limits, that it is impossible to treat it in the same manner as the other great divisions. To facilitate reference, however, it will be discussed in detail under three sections, as follows :—"Northern," including the territory lying north of 20° N. lat., and west of 20° E. long., and, on the eastern side of 20° E. long., all north of the equator ; "Southern," embracing all south of the equator; and "Western," the portion bounded on the north by the 20th parallel, on the east by 20° E. long., and on the south by the equator.

The gold production of the African continent probably possessed a greater importance in the 15th century than it has ever attained since, by reason of the more extensive finds of the precious metal in other countries offering less inconvenience to the miner. But it is exceedingly difficult to arrive at any reliable statistics of the total output of gold in Africa, either in ancient or modern times. Figures relating specially to the several colonies or districts will be found under their respective heads, leaving for notice here the opinions of the various authorities regarding African gold as a whole.

A writer in the *Money Market Review* estimates the gold yield of Africa between the years 1859 and 1865 at no less than 1,450,000*l.* sterling in value per annum, equivalent to about 23,100 lb. (say 10 tons) of fine gold.

Chevalier gives as approximate figures, 4400 lb. in 1800, 8800 lb. in 1847, and 22,000 lb. in 1864.

A third authority places the yearly production at 600 lb. Troy about the year 1800, and 4000 lb. Troy annually since 1850. Dusgate gives the total annual figure at 3744 lb., and Birkmyre at 4000 lb. Professor Suess is of opinion that the present yearly gold-yield of all Africa barely exceeds 4 to 6 million francs in value, or 2554 to 3832 lb. in weight.

Dr. Soetbeer gives the following tabular statement of the approximate export of gold from all Africa in the years 1493-1875 :—

Periods.	No. of Years.	Total lb.	Annual Average.	
			lb.	£
1493-1520	28	184,800	6,600	418,500
1521-1544	24	132,000	5,500	348,750
1545-1600	56	290,400	4,400	279,000
1601-1700	100	440,000	4,400	279,000
1701-1740	40	176,000	4,400	279,000
1741-1800	60	198,000	3,300	209,250
1801-1850	50	165,000	3,300	209,250
1851-1870	20	66,000	3,300	209,250
1871-1875	5	33,000	6,600	418,500
TOTAL PRODUCTION.				TOTAL VALUE.
1493-1850	358	1,586,200		100,579,500
1851-1875	25	99,000		6,277,500
1493-1875	383	1,685,200		106,857,000

NORTHERN AFRICA. *Morocco.*—Morocco figures largely as an exporter of gold, but the bulk of it would seem to be derived from the Soudan (see p. 35). Nevertheless, Morocco is not devoid of gold-mines. Thus Jacob repeats the reports that gold- and silver-mines were formerly worked by the Portuguese in the province of Susa, near to Mesa. More recently, Rohlfs alludes apparently to the same spot, when stating that, according to the natives, the mines in the neighbourhood of Tarudant (at the foot of the southern slopes of the Atlas, 4 or 5 miles from the river Sus, on its right bank, and 2 days' march from the sea), produce gold and other metals in great abundance. Leared also speaks of several mines of copper, combined with gold, in the same ridge of the Atlas.

Tripoli.—Tripoli is officially reported to have exported gold-dust to the value of 1500*l.* in 1878, 3000*l.* in 1879, and 5000*l.* in 1880. Part of this, undoubtedly, is brought by caravans from the Soudan, and there is no evidence to show that any of it is produced in Tripoli itself.

Egypt.—As to the existence of gold-mines in Ancient Egypt, there is abundant testimony. Strabo (book xvii., c. 2, § 2: Bohn's edition, iii. 270) alludes to the mines of gold in the so-called "island" of Meroë.

Herodotus (Thalia, iii. 17, 23: Laurent's translation, I. 206, 208) says "the Macrobian Indians, dwelling on the southern coast of Libya . . . took them to a prison for men, where all were confined in golden shackles; brass, with these Ethiopians, being the scarcest and most esteemed of the metals." Rawlinson, referring to this same passage, states that it is very uncertain where the Macrobian Ethiopians dwelt, and points to the Somali country. He adds that gold abounded in Ethiopia; it is found on the frontiers of Abyssinia, and even in the Bisháree desert, which is called Edreesee and Aboolfeda, "the land of Bega," a name the Bisháree Arabs still give themselves. There will be occasion to revert to these mines, and to describe them at some length (see pp. 5–10).

According to Prof. F. E. Engelhardt, Egypt below the Cataracts contained no gold-mines; but on the eastern side of the Nile, in the primitive districts lying between the Cataracts and the Red Sea, were gold-mines which were worked in the times of the Ptolomies, and were probably known also to the Pharaohs. Belzoni discovered very ancient mines in the Zahara Mountains (which are only 6 hours' journey from the Red Sea, in lat. 24° 30′ N.). Cosmas, who visited Ethiopia about 535 A.D., mentions the country of Sasu, bordering on Abyssinia, as being very rich in gold-mines.

The Souakim merchants deal in gold which is brought from the Fazooglu country, and where it must exist in considerable abundance. The Fazooglu country is a large district above Sennar, in the Egyptian province of Khartum, which pays an annual tribute of 650 (others say 1200) oz. of gold. Burton records of this district that as late as Mohammed Ali Pasha's day, an Egyptian expedition, sent up through Fazooglu in search of the precious metal brought down by the eastern tributaries of the Nile, failed because the ignorant Turks expected to pick up ounces where they found only grains.

Pinkerton speaks of the gold at Sheibôn, which is the same as the modern Seizaban, on the western bank of the White Nile, in Takale or

Takla, in Kordofan (12° N., 32° E.). "Near this place, in a deep glen or valley, much gold is found, both dust and in small pieces. The natives collect the dust in quills of the ostrich and vulture, and in that condition sell it to the merchants. Luca is another place famous for its gold, which, as at Sheibôn, is the only medium of exchange."

Abyssinia.—From Abyssinia, gold is one of the principal exports, but it comes from the interior of the continent, forming an article of the transit trade through Adowa. According to Pliny (book vii., c. 57: Bohn's edition, ii. 225, note), Pangæus is generally described as a mountain on the confines of Macedonia and Thrace; but Marcus says that it is a mountain of Abyssinia, near the source of the Nile, and he adduces various passages from the ancients to prove that the Egyptians had an extensive traffic there in gold at a very early period (Ajasson, vi. 191-2).

Somali-Land.—Of Adel or the Somali country, it is said that gold-dust is exported from Zeila and Berbera.

The Bisháree Mines.—Having dealt generally with the known sources of gold in Northern Africa, it remains to enter into fuller details concerning the mines (mentioned on p. 4) of Bisháree (known also as Edreesee, Aboolfeda, Bega, Ollagee, and Etbaye), which seem to have been by far the most important.

Some interesting allusions to these mines are made by Dr. Brugsch Bey. The tributes and taxes, which under the third Thutmes were yearly contributed in rich abundance to the Pharaoh by the conquered nations and his own subjects, seem, from the reign of Seti, to have flowed in less freely, while the wants of the kings were the same, and the erection of costly buildings required a great expenditure. New sources had therefore to be opened up for the requisite means. So they began to devote special care to the regular working of the existing gold-mines in Egypt and Nubia, and, what was of the first importance, to give the needful attention to the formation of wells in the midst of the arid mountain regions, whence the gold was to be won.

One of these regions was the expanse of desert on the eastern side of the Nile, opposite Edfou, which at this day bears the name of Redesieh, and contains the remains of an old Egyptian rock-temple. It marks the site of one of the resting-places on the great road of commerce, which in ancient days led straight through the desert from the town of Coptos, on the Nile, to the harbour of Berenice on the Red Sea. The inscriptions on the temple date from the time of Seti. They not only establish the existence of gold ore in the interior of the mountain, but also the position of a well (*hydreuma*, as the Greeks called it), made at the command of the king. They relate how, in the 9th year of King Seti, in the month Epiphi, on the 20th day, the Pharaoh undertook a journey to the solitary mountain region, as it was his wish to see for himself the gold-mines which existed there. After he had climbed many miles, he made a halt, to take counsel with himself, and to come to a conclusion upon the information he had received, that the want of water made the road almost impassable, and that travellers by it died of thirst in the hot season of the year. At a proper place, a well was bored deep in the rocky ground, and a small rock-temple was made there "to the name of King Seti," by the express order of the Pharaoh. Thereupon everything was done to carry on the gold-washing to success. The people who followed this laborious occupation were placed under the supervision of a *hir-pit* or "overseer of the foreign peoples," and all other measures were taken to ensure for all future time the keeping up of the temple.

But whether, after all, the gold-mines yielded rich produce, whether the gold-washers delivered to the "reckoner of silver and gold of the land of the country of Upper and Lower Egypt, Hi-shera," the shining grains obtained by their laborious employment in satisfactory quantity—on these points, the lay of the poet on the monuments is silent.

Later on, in order to increase his revenues and fill the treasury of the State, Ramses, following the example of his father Seti, turned his particular attention to the gold-districts which had been discovered, and especially to the Nubian gold-mines of what is now the Wady Alaki (Al-aki), anciently called Aki-ta. But water was wanting in the dreary sterile valleys of this mountainous country, and men and beasts died on the roads to the gold-districts.

By a curious accident, the old Egyptian map has been preserved (at Turin) which enables us to recognize the situation of the mountain tracks, the roads, the places where the gold was found, the wells, and all the other appurtenances and buildings. Here, according to the annexed inscriptions, are "the mountains out of which the gold was extracted; they are marked with a red colour;" there "the roads which have been abandoned, leading to the sea;" here "the houses . . . . of the gold-washing;" the "well," and the "memorial-stone of King Mineptah I. Seti I.;" there "the temple of Amon in the holy mountain." Nothing is forgotten which would seem calculated to give the spectator an idea of the state of the region, even to the stones and the scattered trees along the roads.

Seti I. (Sethos), the gold-seeker, had first worked the gold-mines, but without any remarkable success, as will be shown further on. He made the well named in the inscriptions, and erected near it the memorial-stone of which the inscription on the map speaks. The shaft of the well had a depth of more than 63 yd. (120 Egyptian cubits), but the water soon became exhausted, and the mine was abandoned.

It was not till the third year of the reign of King Ramses that the works were opened, which are mentioned with such detail in the inscription which covers a stone that was found at the village of Kouban, opposite Dakkeh, on the eastern bank of the Nubian territory. Here was situated in ancient times a fortified place, provided with walls, trenches, and towers, destined by the Pharaohs for a bulwark against the irruptions of the Nubian tribes. This place seems at the same time to have been the point of departure for the communication with the gold-mines, in which the prisoners of war and malefactors were forced to carry on their laborious work under the burning rays of a tropical sun. Even to the time of the Greeks, remembrance was preserved of the cruel treatment and dreadful condition of those condemned to the gold-workings.

The Bisháree mines are mentioned by Agatharcides of Cnidus (about 170 to 180 B.C.). He places them "near the mountain Altahi, not far from the ancient Berenice Panchrysos, in lat. 22° N. They were worked by a numerous body of people, including men, women, and children, to each of whom a portion of labour was assigned, corresponding to their strength and skill. The discovery of them was made by the kings of the ancient race. The operations in the mines of Nubia were interrupted by the invasion of the Ethiopians, who took possession of them (700-800 B.C.), and afterwards by the Medes and Persians. In the passages of the mines were found many tools of brass, iron being then unknown, and vast masses of human bones, of people who had been buried in the ruins. The extent of the subterraneous galleries is so great that they must almost have reached to the sea."

These same mines are pointed to by later writers as being situated at Ollagee, and lying about 17 or 18 days' journey to the S.-E. of Derow, a village somewhat above Kom Ombo. Wilkinson alludes to them when he says, "Another source of wealth was derived from the gold-mines in the desert of the upper country. Their position, still known to the Arabs, is about S.-E. from Bahayreh, a village opposite the town of Edfou (24° 58′ N.) or Apollinopolis Magna, and at a distance of nearly 10 days' journey from that place, in the mountains of the Bisháree."

The Arab writers Edrisi, Ebu-Saïd, and Aboolfidda place the mines at Gebel Ollagee, a mountain situated in the "land of Bega." The gold lies in veins of quartz in the rocks bordering an inhospitable valley and its adjacent ravines; but the small quantity the mines are capable of producing by immense labour, added to the difficulty of procuring water, and other local impediments, would, in Wilkinson's opinion, render the re-opening of them at the present day an unprofitable speculation; and indeed, in the time of Aboolfidda (or Omad-édeen-Aboolfeda, Ismail-ben-Nasser, who was king of Hamah in Syria, and lived about the year 730 of the Hegira, A.D. 1334), they only just covered expenses, and have never been worked since they were abandoned by the Arab caliphs.

According to Agatharcides' account, the toil of extracting the gold was immense: it was separated from the pounded stone by frequent washings, and this process appears to be represented in the paintings of tombs executed during the reign of Osirtasen and other ancient Pharaohs. There is no positive notice of the first discovery of the mines, but it is reasonable to suppose that they were worked at the earliest periods of the Egyptian monarchy; and the total of their annual produce is stated by Hecatæus (Diodorus i. 49, on his authority) to have been recorded by a monarch of the 18th dynasty.

The Bisháree mines were made the object of very careful exploration (in 1868) by Linant de Bellefonds Bey, who published an exhaustive account of them, accompanied by an elaborate atlas of plans and views. This work, quoted in the bibliography at the end of the present volume, and a copy of which is preserved in the library of the Royal Geographical Society of London, is the source whence the following remarks have been mainly derived.

In traversing the Wady Ollakee from its embouchure into the Nile (about 23° N.) the explorer found much quartz débris in the bed, and grains of native gold in the quartz. In the hill bordering the Wady Mourrat, veins of quartz were seen coursing through talcose schists, and showing rare signs of native gold. The scarcity of water in this region had necessitated the adoption of an ingenious method of utilizing it for washing purposes, which is illustrated in Fig. 1. At *a* is a sump or water pit; *b* is an inclined plane on which the mineral is washed, and whence the water escapes into the tank *c*; *d* is a conduit for conveying the water back to *a*, to be used over again; *e* is the ordinary Egyptian *chadous* or lever-pump for raising water.

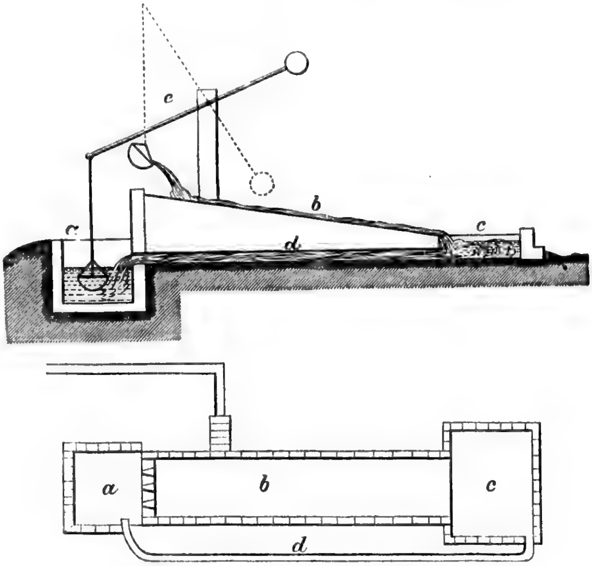
The method adopted for treating the auriferous ore seems to have been as follows. First it was broken into small fragments about ¼ in. cube, by placing it in natural hollows in the surface of the rocks, and pounding it with rounded blocks of porphyry; this broken mineral was then reduced to very fine powder in hand-mills, and washed on an inclined plane as shown in Fig. 1. The labour incurred was enormous.

At Ceiga (22° 30′ N., 33° 50′ E.), were found very extensive traces of former workings, which appeared, however, to have been deserted only by reason of the ore being exhausted, as all the hand-mills and other implements remaining were worn out and useless, and no trace could be found of existing auriferous mineral.

The mines of Derehib (21° 40′ N., 35° E.) seem to have possessed the greatest importance. The excavations are immense, and have been prosecuted wherever an auriferous quartz vein showed itself in the schist. Yet no traces of tools, mills, or washing-places were discernible. The explorer quotes (pp. 74-76) at length from Diodorus (book iii., c. 6), and from the Arab writer surnamed Macrizi, who lived in 1385 A.D., or 1430 years after Diodorus; the identity of the mines described by these writers with the ruins discovered by Linant de Bellefonds seems clear.

Somewhat to the west of Derehib, and on the southern side of the same range, are the deserted mines of Chawanib, where abundant evidence was found, not only of the working of the quartz veins which traverse the primitive (schistose) rocks, but also of the washing of auriferous sands brought down by the rains from the higher portions of the range. The workings do not appear to have been exhausted by the miners, but abandoned from some other cause.

FIG. 1.



ARAB METHOD OF UTILIZING WATER.

The places indicated on Linant de Bellefonds' map, as possessing deserted gold-mines, are as follows:—

Oum Guereyatte .. ..
Ceiga.. .. ..
Gebel Offene .. .. ..
Gebel Abdulla .. .. ..
Gebel Matchouchelennaye
Gebel om Cabrille .. ..
Tamille .. ..
Gebel Essewed.. .. ..
Gebel Tellatabd .. ..

} Situate in the country of the Cawatil Arabs, between about 21° 30′ and 22° 40′ N., and 32° 50′ and 34° 20′ E.

Oum Teyour	In the country of the Mansour Melecab Arabs, lying east of the foregoing and west of 35° 20′ E.
Wady Sohone	
Wady Hagatte	
Wady Affawe	
Wady Daguena	
Wady Camolit	
Derehib	
Wady Chawanib	
Raft	In the country of the Foukara Arabs, between 20° and 21° N., and about 32° 30′ E.
Kellé	
Absab	

The veins in nearly all cases have a N.-W. and S.-E. direction. Whether it would be profitable to re-open the workings, and apply modern machinery and methods to the extraction of the gold from the quartz, could only be decided by an expert. But the absence of food, water, and fuel in the neighbourhood constitutes a most serious drawback.

SOUTHERN AFRICA.—*The Zambesi-Lydenburg gold-field.*—The auriferous region lying between the rivers Zambesi and Limpopo, partly in Sofala and partly in or on the borders of the Transvaal, does not admit of piecemeal description, as it really forms one vast gold-field. As such it will therefore be treated. See sketch-map, Fig. 2.

In Hartmann's Latin translation from the Arabic of Edrisi, he says, "Omnium præstantissimum aurum in universa Sofala regione ibi reperiri."

Capt. Burton considers that the great gold-fields north of and near the Zambesi, and north-west of Natal, beyond the Transvaal, a country consisting of metamorphic rocks and auriferous quartz, will probably be found extending high up in Eastern Africa, throughout the rocks lying inland of the maritime and sub-maritime coralline ranges. The same author narrates that about the middle of the 16th century, the Portuguese determined to seek for the gold in Eastern Africa, of which they had heard, and King Dom Sebastian sent an expedition under the command of Francesco Baretto to Sofala; he penetrated into Macoronga and Manica, and discovered and made himself master of the gold-mines.

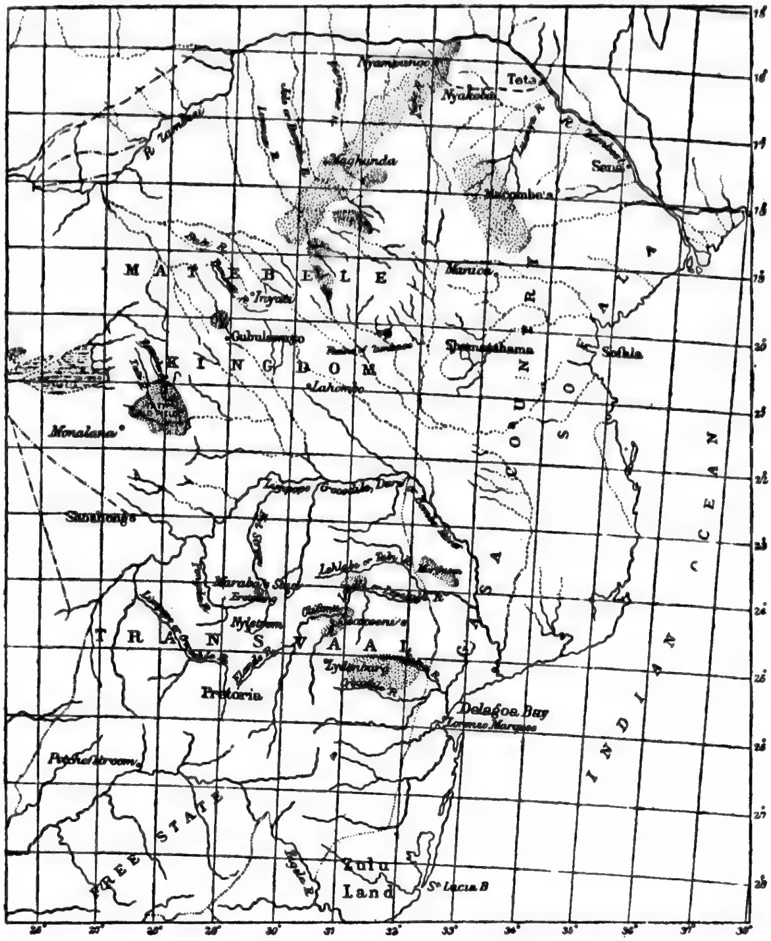
Dr. Livingstone says that gold is washed for in the beds of rivers, within a couple of days of Tete,* on the Zambesi, 16° S., 33° 50′ E. The natives are fully aware of its value, but seldom search for it, and never dig deeper than 4 or 5 ft. Only common wooden basins had hitherto been used. Beyond Senga lies a range of mountains called Mashinga (13° S., 32° E.), to which the Portuguese in former times went to wash for gold. In the neighbourhood of Tete (Zambesi), they call gold in the native language *dalama*.

The Doctor adds that if we consider Tete as occupying a somewhat central position in the [Zambesi] coal-field, and extend the leg of the compasses about 3½°, the line which may then be described from

---

* The reader must not confound the Tete Zambesi, or Northern] system, in 16° S., 34° E., with the Tati [Thati, Tatin, Victoria, or Southern] system, in 21° S., 28° E.

FIG. 2.



SKETCH-MAP OF ZAMBESI-LYDENBURG GOLD-FIELD.

N.-E. round by W. to S.-E. nearly touches or includes all the district as yet (1857) known to yield the precious metal. We have 5 well-known gold-washings from north-east to north-west. There is Abutuu, not now known; but it must have been in the west or south-west, probably on the flank of the eastern ridge. Then the country of the Bazizulu, or Mashona, on the south, and Manica on the south-east. The rivers Mazoe, Luia, and Luenya in the south, and several rivulets in the north, bring gold into the coal-field with their sands; but, from much trituration, it is generally in such minute scales as would render amalgamation with mercury necessary to give it weight in the sand, and render the washing profitable. The metal in some parts in the north is found in red clay-shale, which is soft enough to allow the women to pound it in wooden mortars previous to washing. At Mashinga,* it occurs in white quartz. Some of the specimens of gold which he saw from Manica, and the country of Bazizulu (Mosusurus?), were as large as grains of wheat, and those from rivers nearer Tete were extremely minute dust only. He was thus led to conclude that the latter was affected by transport, and the former showed the true gold-field as indicated by the semicircle. Was the eastern ridge the source of the gold, seeing it is now found not far from its eastern flank?

There is thus at present a coal-field surrounded by gold, with abundance of wood, water, and provisions. In former times, the Portuguese traders went to the washings accompanied by great numbers of slaves, and remained there until their goods were expended in purchasing food for the washers. The chief in whose lands they laboured expected a small present—1*l.* worth of cloth perhaps—for the privilege. But the goods spent in purchasing food from the tribe was also considered advantageous for the general good, and all were eager for these visits. It is so now in some quarters, but the slave trade led to the withdrawal of industry from gold-washing; and from 130 or 140 lb. weight annually, the produce has dwindled down to 8 or 10 lb., which is obtained by independent natives, who wash at their own convenience, and for their own profit. From superstition and from fear of the earth falling on him, no native will dig deeper than his chin; and on finding a piece of gold, he buries it again, governed by an idea that without this "seed" the washing would ever afterwards prove unproductive.

According to James Macqueen, the place for the celebrated fair of Manica is situated between two small rivers, the Revue and the Mucorumaze, which are tributaries to the Mungora, and joined by the river Mazavios. Descending from the south-west from the mountains of Fura, their united streams are joined below by the Rucuto, and soon afterwards by the combined waters of the Revue and Mucorumaze. The country around is hilly. In early times, the quantity of gold annually found here was large. When Galvao da Silva was there (in 1788), the supply was very much reduced, owing to the insecurity that reigned in the district, and from the sluggish and careless manner in which the natives performed their work, carrying it on chiefly near the surface of the earth. They dig openings about 6 ft. in depth, and about 12 ft. in diameter, and by the rudest process separate the ore from the earth. The gold thus obtained is afterwards carried chiefly to Sena and Tete, and thence to Mozambique. In the mountains of Fura, the precious metal is very abundant; and in a state called Manica it is found in white quartz, and is called by the natives white gold.

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* Not to be confounded with Machanga in 5° N.

Again, he says that the Arroango divides the lands of Tete from the territory of Sena, and the part of Manica where the fair is separated from Barue. This province (Tete) is rich in gold. Tete carries on much trade with the country of the Maraves, an industrious people inhabiting a fertile and healthy district to the north of the Zambesi, abounding in many places with gold, especially about Java and the river Bua (the river Bua runs into Lake Nyassa). In 1808, Mozambique trade included: gold, 100,000 *cruzadoes* (1 *cruzado* = 400 *reis* = 1*s*. 9½*d*.).

In a paper read (1875) before the Geographical Society, St. Vincent Erskine expressed an opinion that it was extremely desirable that the country between the Limpopo and the Sabia should be explored, as a part of it is described in old geography books as Sophala [Sofala], or Sophira, or Sophir, and Monomotapa (which last signifies in Zulu "the children of the mines"), and is stated to be very rich in gold, several millions sterling annually having been exported thence by the Portuguese. Nothing (in Major Erskine's opinion) can more convincingly prove the existence of large gold-mines than the fact that it is death for a native to speak of them or of the ancient ruins. All the chiefs show the greatest jealousy about these mines, and it is therefore extremely difficult to ascertain their whereabouts. Gold can even now be bought in the country from the natives. His own opinion is that it is the ancient Ophir. The Queen of Sheba's real name was Sabia, a name which is even now given to a river there. In some maps, Sofala is called Sophir. The "S" is merely a prefix, and it is therefore reasonable to suppose that the original name was Ophir. In a geography book, 80 years old, in his possession, it is stated that the Portuguese exported annually 3,000,000*l*. worth of gold.

Umzila aims at keeping the gold produce of Manica to himself. He refused (1878) St. Vincent Erskine permission to visit the fields, and told him that when his ivory was done, he intended to work them for his own benefit. The Matabele [Amandabele] country is one of the richest gold-producing regions in the world, if reports be true. Lobenluga, the chief, promised him (1878) not to allow anyone to prospect in it who is not recommended by the British Government, though the Portuguese had made several attempts to get concessions.

Sir John Swinburne, Bart., lecturing in 1870 at Newcastle, stated that the "southern" or Tati gold-field, so far as the actual metal had been found, extended from N.W. to S.E., a distance of 40 miles by 14 broad. The Tati settlement is in 21° 27′ S. and 27° 40′ E. There are 5 different mines within a mile of the settlement, two at 3 miles to the S.E., one at 13 miles to the N., two at 12 and one at 35 miles up the river to the N.W., making 11 mines from which gold had been extracted. Several shafts were 50 ft. deep; one about 100 ft. All these mines are on ancient workings; no tools have been discovered, but stone mortars, evidently used for crushing the ore, have been found on the banks of one of the mines. They have been worked after the style of quarries, leaving great holes or pits 70 ft. deep; trees are now growing in these workings, which must have taken 150 to 200 years to reach their present size. The reefs consist of quartz between walls of chloritic schist; the strike is from N.W. to S.E., the dip about 50° to the S.W., and varying from 6 in. to 6 ft. in width. There are two descriptions of quartz, one red and one honey-combed, and containing much oxide, peroxide and some white sulphides of iron; while traces of sulphuret and carbonates of copper were also found. The gold, which is very fine, is mostly found in the oxide and peroxide of iron, and is only now and then seen in the white quartz without iron. The other kind of quartz is of a bluish-grey appearance, without any iron, and of a finer texture; but it is only found 3 miles to the E. of the Tati settlement, in a vein 6 ft. wide, and the gold therein is coarser and more evenly disseminated than in the red ore. Two shafts have been sunk upon this vein to the depth of 60 ft., without meeting with sulphides or oxides of iron. The Limpopo Co.'s mill was (1870) crushing quartz from one of these mines which produced 1½ oz. per ton.

With regard to the "northern" gold-fields, it appears that they lie to the N.N.E. of the Tati, a distance of about 327 miles. The whole of the country between the Inyati and the Ramakoban has quartz reefs and schistose rocks interspersed through it, more particularly in the neighbourhood of the Kumalo river, but there is (1870) no evidence of gold having been found in those reefs. About 100 miles east of Inyati is the Bembees, the southern boundary of the northern gold-field, and in this neighbourhood there are numerous quartz reefs in which gold has been found. Some 3 or 4 miles west of the ford at Umfulinoer, a couple of shafts have been sunk to a depth of 35 to 40 ft. upon one of the reefs, that has produced gold in small quantities; but they have had to be abandoned, as all whites were compelled to leave by the Matabele. The reef was 2½ ft. thick, the quartz very similar to the red quartz containing iron found at the Tati. There are numerous ancient workings all around. The locality is in 18° 11′ S. and 30° 34′ E. Tati is 205 miles, and Zumbo on the Zambesi due north, 160 miles distant.

According to Macleod (says Burton), the district is called Matouca [or Manica]—the Matuka of Dr. Livingstone's map, and the gold-washing tribes, Botongos. The spots containing the metal are known by the bare and barren surface. The natives dig in any small crevice made by the rains of the preceding winter, and there find gold-dust. These pot-holes are rarely deeper than 2 or 3 ft.; at 5 or 6 ft. they strike the bed-rock. In the still portions of the rivers, when they are low, the natives dive for nuggets that have been washed down from the hills. Sometimes, joining together in hundreds, they deflect the stream, and find extensive deposits.

The richest gold-fields discovered in 1867 by Karl Mauch are said to be in the Manica district, only a little further to the west, down the Swaiswa and Fole. They reach to within 50 miles of the Zambesi.

From a letter of Dr. Exton's, it appears that the gold-field pointed out by Hartley, and from which Mauch and Hartley took specimens, lies on the north bank of the river Tati, a tributary of the Shashi, itself running into the Limpopo. The country-rock is green talcose slate, through which the 3 principal veins of quartz run in a south-easterly direction, that being the strike of the strata. These veins are between 18 in. and 2 ft. wide, and in two only has gold been found. The dip of the strata is 75°. Granite is the prevailing formation, passing, as the Thati is approached, into a schistose sandstone. The auriferous quartz veins are limited to the narrow reefs in the slate north of the Thati. Where the two formations are in contact, there is a fine friable detritus, yielding some gold on washing, the rest of the precious metal being distributed in minute particles through the quartz.

It is stated by Dr. Holub that the discovery that only quartz-gold and not alluvial was to be obtained on the Tati field, damped the ardour of the miners. As a general rule, not more than 7 oz. of gold were found in a ton of quartz, though he was told that exceptional cases had been known where one ton of quartz had yielded 24 oz. of gold. Difficulties encountered were the want of pumping machinery, and the great cost of transport from the coast.

The following additional localities where gold exists in this region have been copied, by the kind permission of Fred. A. A. Simons, Esq., from his manuscript notes of a journey made there about 4 years ago; they are:—The territories and streams of Macequece, Missale, Cabura-manga, and Macanga, all on the left bank of the Zambesi; and, on the right bank, some mines at Muzozuros, about 6 days from Tete. Also at Masingua, 10 days from Tete; at Vumba; at Orobezes, Buirœ, and Machanacha, in the territory of Changamire, formerly called Monomotapa; and at Boxa, Nhamucauga, Guenge, Duma, and Pendico, all near Tete.

Salt, the Abyssinian traveller, disparages the production of the Sofala region, remarking that the only way by which gold is now (1809) procured is by washing the sands of the rivers; "in this manner a considerable quantity is still annually accumulated, though it seems to be rapidly decreasing; for in 1593 the Governor of Mozambique, George Menzes, collected for himself and the Viceroy of India 1,000,000 *crusades*, and I do not believe that one third of this amount is now altogether annually produced." Jacob adds that the *crusade* was probably $\frac{1}{32}$ oz. of gold, value about 2*s.* 6*d.*

By far the most elaborate and extensive account of the Zambesi-Lydenberg gold-field is given by the painstaking traveller Thomas Baines, from whose volume the following lengthy notes are taken.

The country of Monomotapa, a name which in itself signifies a place whence something valuable is derived, lies S. of the Zambesi, which was discovered by Vasco de Gama in 1498. It may be roughly stated as lying between 16° and 20° S. and 30° and 35° E. The country, according to the early historian, abounded in gold, which in great quantities was extracted from veins in many of the provinces, especially in the kingdom of Torva. In 1650, an expedition under Francesco Baretto was sent to explore these fields, but from sickness, &c., never reached them. The Portuguese subsequently settled on the Zambesi, and in an ancient work accessible in Natal, it is stated that the quantity of gold sent from their possessions amounted to 2,000,000 *metigals*, estimated at 1,001,354*l.* sterling. In later times, 130 lb. per annum have been sent home; but in the palmy days of the slave trade, the annual expeditions to the Luenya and other rivers in quest of alluvial gold were discontinued. Gold is still brought down by the natives in small quantities to the Portuguese settlements along the coast.

The Zambesi gold-fields are situated N. of the watershed line, between the Zambesi and Limpopo rivers; the Tati gold-fields S. of same.

On the Tati or Victoria gold-fields, Matabele-Land, H. Hartley, whilst hunting in 1865, observed groups of ancient diggings, and connecting these with the rumours amongst the Dutch emigrants of gold beyond the Zoutpansberg, invited Karl Mauch to accompany him, who in 1866 announced the discovery of a gold-field 80 miles long by 2 or 3 miles broad. In the next 3 or 4 years, several joint-stock companies and private associations were formed to test its richness, but although the yield per ton seems to have been good, no one appears to have made a success. The London and Limpopo Mining Co., headed by Sir John Swinburne, Bart., took with them an expensive equipment, including a traction engine, which, however, was left, and subsequently sold in Natal, there being no road on which it could travel.

Some samples sent to London, and assayed by Johnson, Matthey & Co., gave as follows:—New Zealand reef, gold, 4·900 oz. per ton of 20 cwt., silver, traces; New Zealand reef, gold 10 oz., silver 0·900 oz.;

Alliance reef, gold 65·250 oz., silver, 3 oz.; Burrell's reef, gold 0·500 oz., silver, traces; Pioneer reef, gold 39·725 oz., silver, 3·250 oz.; Blue Jacket reef, gold 4·700 oz., silver, traces; 5 pieces of quartz, gold 20·250 oz., silver, 1·250 oz.; 1 piece of quartz, gold 52·250 oz.; silver, 3 oz. Another specimen, tested by Claudet, gave 26·8 oz. gold, and 31½ oz. silver.

Early in 1876, Capt. Levert, of the London and Limpopo Mining Co., erected crushing-machinery at Tati, with the following result, as certified by B. N. Acutt:—

Name of Reef.	Quartz crushed.	Yield of Gold.	Yield per ton.
	tons cwt.	oz. dwt.	oz. dwt. gr.
Blue Jacket	19 10	42 0	2 3 1
Australian reef A	2 10	16 10	7 12 0

Capt. Levert also certified that 125 oz. had been produced from the reefs at or near the Tati during the same year.

A party of 34 Australians, who were equipped in Natal in 1869, and sent to the gold-fields, sank 80 ft. on the vein, but did not find it widen out as they had hoped; they, however, obtained 25 oz. 3 dwt. 12 gr. from 2 ton, 10 cwt. 2 qr. 24 lb. of quartz. One of the party wrote in 1871 that they had crushed 5 tons of quartz at the end of 1870, and received as proceeds 43 oz. of retorted gold, or over 8 oz. of gold per ton of stone, and that they expected the 40 or 50 tons of stone raised since would yield the same average.

Greite, who was left by Sir John Swinburne to work the Blue Jacket reef, went down 70 ft. on it, and reached water; he raised about 300*l.* worth of gold, and had 150 tons of quartz lying on the surface in assorted heaps, of which the most promising he thought would yield 10 oz. of gold per ton. He showed Baines several picked specimens of quartz of great richness, one estimated at 1500 oz. per ton.

Baines was told on good authority that out of 74 tons of quartz raised by the Australians at Todd's Creek, 226 oz. of gold were obtained, 170 of which were from the first 40 tons. Towards the close of 1872, he was informed by Acutt that between 1500 and 2000 oz. of gold had been sent home from Tati.

The northern gold-fields of Matebele-Land were discovered in 1866–67, only a few weeks after those of Tati, from which they are distant 350 miles to the N.E.

In the vicinity of Emampanjene or Umbanjin (18° 42′ 30″ S., 29° 44′ 30″ E., height 3900 ft.), Nelson found several large quartz reefs, one, 5 miles N.N.E., 100 ft. wide, striking N. 35° W., with a S.W.

dip of 70° or 80°; and, about 4 miles S.W., two large and several small reefs. The first did not look very favourable; but the others appeared better, and contained much oxide and sulphuret of iron, as well as brown hematite or peroxide of iron. Want of time and means prevented Nelson from breaking up much of this quartz to examine it for gold; his opinion, however, was that some of the reefs were auriferous. He washed gravel and sand in the Changani and M'Nyami rivers, and readily found several specks of gold in every part. He tried the river (which?) 35 miles down with the same result, and found gold also in red ferruginous gravel about 500 ft. from the river. From these indications, Nelson thought that payable alluvial gold might be found in the Lhangani or its various feeders. A band of talcose, chloritic, and hornblende schist, with numerous quartz ledges, in which Nelson obtained a fair prospect of gold, lies 8 or 10 miles S.W. of the village. Where the main road touches the Quaequae river, they found extensive slate and schistous rocks, striking N. by W. and S. by E., with numerous quartz reefs, some of which were proved to be gold-bearing. About 8 or 10 miles north of the junction of the Bembesi river and the Sebaque (Sebaque, 18° 15′ 7″ S., [illegible] 24′ E., height 3420 ft.), many apparently rich quartz reefs exist. Nelson tried the river, and found a trace of gold. Hitherto the chief features of the country had been granite; but to the north-west of their course, greenstone schist was found, and beyond that a dark slate formation, striking N. and S., and upright enough to enclose the stream between high bluffs. Nelson found alluvial gold in two places in the river; but it was very fine, and not enough to warrant him in calling it payable. At the drift of the Umzwezwie, he found gold among the stones, and in the sand of the broad bed which only the flooded river could fill; also subsequently a little gold in the Sarua river, whence they proceeded N.N.W., crossing the Inzinghazi river, forming camp on a large river called the Ganyana (17° 44′ 56″ S., 30° 41′ 20″ E., height 3953 ft., 1195 miles distant from Pietermaritzburg). Here Nelson found several quartz reefs to the west of the road; one striking N. to W. was 150 ft. wide, forming several hills in line, which were visible from afar. He does not think this gold-bearing, but considers it, nevertheless, well worthy of examination.

At 35 miles to the north-west of this camp is Maghunda village (S. lat. 17° 33′ 30″; E. long. 30° 17′ 40″, 1230 miles from Maritzburg), where are pits whence the precious metal was, in olden times, extracted. The reef, bordered by clay-slate and other rocks, traverses a valley shut in by rounded hills; and the pits are in groups of 6 or 8 together, 3 or 4 ft. wide, and some of them 10 ft. deep. As Baines returned, he saw several other quartz reefs and groups of diggings, in all of which gold-bearing stone had evidently been found.

At the junction of the Simbo rivulet with the Umvuli, are extensive old diggings. The reefs seemed to be the greater part of a mile in length, but were so covered with refuse thrown from the old surface workings, that their exact limit could not easily be determined; the holes were 3 or 4 ft. wide, and sometimes 10 or 12 ft. deep. Here and there a group of holes had been worked into one, forming a large pit, and in many of these, mimosa and other trees, 3 to 10 in. thick, were growing, proving that many years must have elapsed since they were worked, but not establishing for them a high antiquity. A native remembers that a house stood some distance north, and in his father's time it was inhabited, and gold-dust was sold there. Perhaps, it might have been the residence of some one combining the operation of trading with the office of catechist or teacher from the now deserted Jesuit mission, at Zumbo, on the Zambesi. The party marked off these reefs as their first claim. The following is Nelson's official report on them:—

"Profitable quartz mining depends largely on the facilities for working and crushing; here these are very good, an unlimited supply on the ground, and a fine stream, the Simbo, within a few hundred yards, with constant water, which can probably be used as a motive power.

"The rock strata enclosing these veins are gneiss, and a mixture of talcose and chloritic schists, striking N.E. and S.W., or thereabouts; and these dip westward at an angle of 70° or 80°, judging by the dip and strike of the rocks lying close on both sides of the hill.

"Just where the reefs are, the underlying formation is so covered with soil that it cannot be seen. Everywhere in the northern mining district the stratified rocks are so hardened and metamorphosed, that their geological age cannot be ascertained. I believe they belong to the lower palæozoic epoch.

"On the N.E. boundary of the chain are several kopjies, or small hills of igneous rocks—Hartley Hills (S. lat. 18° 31′ 39″, E. long. 30° 49′ 20″; height, 3079 ft., from Pietermaritzburg, 1157 miles)—which have burst through the rocks containing the quartz veins, and pressed them aside; hence, though by the line of old workings, the reef No. 1 appears to have a N. and S. strike, its real course is N.E. and S.W.

"I cannot tell the breadth of these veins, as they are hidden by refuse quartz from the old workings; but I believe it to be considerable. I brought samples of quartz from these mines, and have assayed them; some gave low results, some high. From one piece of quartz taken from vein No. 1, the result was at the rate of 60¾ oz. of gold, and 17·1 oz. of silver, to the ton; but this was taken from a very choice piece. Since my arrival in London, Johnson, Matthey & Co. have made six different assays of quartz, taken at various places from the old workings, with the following results:—

Sample *a.*	0·225	oz. of gold	per ton.		Sample *d.*	3·150	oz. of gold	per ton.
„ *b.*	1·450	„	„		„ *e.*	3·500	„	„
„ *c.*	3·125	„	„		„ *f.*	0·975	„	„

"The samples *a* and *b* were taken from vein No. 2; *c*, *d*, *e*, *f*, were from vein No. 1. These assays do not afford sufficient ground for estimating the value of the mine; but they prove, beyond a doubt, there is rich quartz in them."

Nearly a mile to the south of these reefs, Sir John Swinburne had two shafts sunk, at 25 ft. deep, from which he obtained some very rich and visibly auriferous quartz,—some white and crystalline, some coloured red or yellow with oxide of iron.

[The fever appears to be terrible throughout the country, as at pp. 39–40, Baines gives an account of seven persons dying out of a little party of hunters, and says that this was a trifle as compared with the deaths in other places.]

About 25 miles from Hartley Hills, down the Umvuli river, are several reefs, formerly worked by the Mashonas; and 21 miles to the N.W. by N. (S. lat. 18°, E. long. 30° 36′) are several groups of very extensive abandoned gold-workings.

About 6 miles east of Maghunda village, is a country extensively quartzose, with old workings all round. Some of these the natives —Mashonas—had within the last twelve months re-opened. They make a heap of the quartz mixed with wood, and burn it. They then crush it between stones, similar to a printer's slab and muller. These workings are 60 miles from Hartley Hills (17° 31′ 30″ S.; 30° 32′ 6″ E.). The country around bore such evident marks of inundation by the summer torrents, that it seemed absolutely certain that a rich alluvial field must exist at the first plain where the speed of the rivers could abate.

The gold-fields of the Transvaal Republic (Maraba-stadt, Eersteling, Lydenburg, Mac-Mac, and Pilgrims' Rest) are next described. Button, proceeding north from Lydenburg, found a little gold in two streams which he crossed before reaching Triegardt's farm, 25 or 30 miles from Lydenburg. He also found fine gold in the crevices of the bed-rock of the river Olifants or Lipalula. His path lay for three days under the Quathlamba or Drakensberg; he then turned N.E., and in two more days reached the Salati river, on the bed-rock of which he found gold, as well as in a gully half a day beyond the river. A little further west is a reef running S.W. by W. to N.E. by E., and 6 ft. or more wide. A body of Kafirs were at work breaking out quartz, in which the free gold was easily visible.

On his second journey, Button started from Lydenburg, and came to a range, shortly after crossing the Salati river, which he named the Murchison Hills. They consist of two ranges about 600 ft. high, running parallel, from W.S.W. to E.N.E., with a valley 6 miles wide between them. The S.E. range is of chloritic talcose slate, in a highly crystalline state; the N.W. is argillaceous—of a deep red colour—from the amount of iron in it. In the main valley are smaller hills with large quartz veins running through them. Auriferous quartz was found in 3 distinct veins, by crushing it between two stones and washing it out with a digger's dish. One reef was about 10 ft. across, another 3 ft., and the third a few inches, but parallel to one 40 ft. wide, capped with cellular quartz full of a red oxide. The months of March, April, and May, are unhealthy, and it would not be safe to enter until the dry season had set in, when water is scarce; but there would be no difficulty, if dams were made in the beginning of October, in securing a supply during the first rains. Button had on his farm at Eersteling, in the Zoutpansberg district (approximately S. lat. 24° 6′ 51″, height about 3800 ft.) an auriferous quartz reef, which he named Natalia, and to continue working which he succeeded in forming a company in England, called The Transvaal Gold Mining Co., Limited, with a capital of 50,000*l.* The reef is in close proximity to clay-slate, and appears to be cased with talcose schist and decomposed sandstone and slate; its direction is about S.W. by W. to N.E. by N., true bearing, with a dip to the N.W.; it appears to extend the best part of a mile, and is about 3 ft. wide, in some places 4 ft.; free gold is visible to the naked eye,—in some cases a regular net-work of gold standing out in high relief all over the stone. Two samples assayed by Johnson and Sons, of London, gave 73 oz. 6 dwt. 21 gr., and 59 oz. 10 dwt. 2 gr. per ton of 20 cwt.

There are alluvial diggings below this reef, extending 3 miles or more down the Eersteling rivulet; at the upper part, the deposit is rather thin, and as neither the gold nor stones are water-worn, they are evidently derived from this reef. But, lower down, the nature of the soil changes: at Venters, gold was found in the latest alluvial deposit at 2 ft. deep; at Dupree's farm, sinkings of about 20 ft. were made, the soil being dark clay sandstone, mica-schist, and alluvial water-worn gravel; on the bed-rocks of hard sandstone or granite, gold in small quantities was found at every prospect.

Karl Mauch, in 1871, discovered the long-sought ruins of Zimbaoe, Zimbabye, or Mazimbaoe, in S. lat. 20° 15′ 34″, E. long. 31° 37′ 45″, and 4200 ft. above the level of the sea. Here he found that the natives had been long accustomed to work for alluvial gold. He reported the gold-field as only half-an-hour north from Pikes Kraal.

On the Tugela river, in Natal, gold-bearing veins have been discovered and worked.

The Lydenburg gold-fields are supposed to extend about 60 miles north and south along the sources of the Blyde river, the Umsaabi, the Crocodile, and the Umkomatie, and eastward perhaps 50 or 60 miles into the "fly and fever country" in the direction of Lebomba.

The Pilgrims' Rest diggings were discovered in September, 1873, by William Trafford; they extend about 5 miles along Pilgrims' Creek, a tributary of the Blyde river, which runs north to the Olifants or Lipalula river, which last in turn empties itself into the Limpopo. Gold was found in the higher lands in the vicinity, as well as in the banks and terraces of the creeks.

Writing in 1878, Fynney says that the Lydenburg gold-fields have been opened for about 4 years; but the feeble government under which they have hitherto existed has precluded all chance of their development, and for the last 18 months they have almost been closed, owing to the war with Secocoeni. Still, with all these drawbacks, they have continued to be worked to some extent.

The Government returns for the year ending December, 1875, show that the Natal Bank exported in that year over 36,000*l.* worth of gold, and the Cape Commercial Bank's exports for the same period exceeded 70,000*l.* It is estimated also that at least 100,000*l.* worth more reached England through private hands.

On the authority of Jeppe, the first traces of gold within the limits of the Transvaal were found by Mauch in July, 1868, on the north side of the Olifants river, near the Murchison range, visited two years later by Button. On the 31st August, 1871, E. Button discovered auriferous quartz and alluvial deposits at Eersteling, between Makapans Poort and Maraba-stadt, where mining operations were carried on for some time. On the 6th February, 1873, the first alluvial gold was discovered near the Blyde river, in the district of Lydenburg, by Parsons, McLauchlin, and Valentine; and on the 14th of May following, the locality was officially proclaimed as a payable gold-field by the Transvaal Government. Since then, auriferous quartz-reefs have been discovered in different parts of the country, viz. in the District of Waterberg, on the farm Buffelspoort, not far from Nylstroom; at Blauwbank (Witwaters Rand); on the Crocodile river, south of Lydenburg; in the Amaswazi country, not far from the line of the projected railway which is (1877) to connect Delagoa Bay with New Scotland; at the sources of the Schoen Spruit, district of Potchefstroom; in the Dwars Berge, district of Marico; and, in July, 1875, alluvial gold was found on the town commonage of Pretoria.

An alluvial field, distant about 40 miles from Lydenberg, was (1874) giving good prospect of paying, according to Percy Hope. Yankee Dan, an experienced Australian miner, working a claim on wages at 4*l.* 10*s.* a week, found 8 oz. in one week, 7 oz. in another, and 17½ oz. during the four days that Hope was on the fields. Many parties' finds averaged 1 oz. per diem.

According to Sir Bartle Frere, great expectations were, at one time, formed of the richness of the Transvaal gold-fields, and a considerable amount of gold is even now extracted from the gold-fields in and beyond the Lydenburg district, about Pilgrims' Rest and Mac-Mac. Much more would probably be worked if the country were settled, but here and in other parts where gold has been worked, as, for instance, in the mountains between Pretoria and Potchefstroom, the gold hitherto found has been, for the most part, in quartz, and cannot be extracted without more machinery and cheaper fuel than the miners have as yet been able to command.

The Transvaal gold-fields were alluded to by the Rev. George Blencowe, at a meeting (1880) of the Society of Arts, in the following terms:—

"Pilgrims' Rest, the most important gold-field as yet discovered in the colony, is a valley running up 4 miles, from the Blyde river in an easterly direction, to an elevation of about 2000 ft. at the upper end. The average depth from a mile east of the Blyde is about 1000 ft. The present surface is covered with soil, from which grass and an abundant and various herbage grow. But down below the present surface, in some cases at the depth of 30 ft., there is the site of an old stream, strewn over with fragments of lava, measuring 1 to 20 ft. square, which have been triturated and ground by the force of the current, till all the smaller ones are rounded and the larger are deprived of their angles. It is here on the upper edges of the larger stones that the gold of the original stream is found. The gold is not confined to the original stream, but has been discovered on the shoulders of the minor ridges and on their tops, where it has not been subject to trituration or any abrading power. On both sides of the Blyde, gold has been found in paying quantities, over an extent of not less than 8 miles square. There has been no registration of the gold found, so that it is impossible to say how much has been obtained. But in January, 1874, the Gold Commissioner, who had been in California, Australia, New Zealand, and other fields, told Blencowe that then more gold had been taken from Pilgrims' Rest than from any "creek" in New Zealand. Similar statements were made to him by men who had been gold-digging in various parts of the world during more than 30 years. Immediately over the eastern ridge of Pilgrims' Rest, Mac-Mac, another field is reached, in which there is no trace of the same kind of violent volcanic or aqueous action. The gold is neither molten nor rusty, but bright and angular, as if it had just fallen from its quartz matrix. Many of the claims at Mac-Mac have yielded well, but the extent of rich ground has not been equal to that in Pilgrims' Rest. About 20 miles further on, in the same direction, is Spitz Kop, a solitary hill, around whose foot some good finds have taken place; but full occupation has been prevented by the unsettled state of the country since a few months after digging was fairly commenced. To the north and north-east of these fields, a wide tract of territory extends, which is supposed to contain large quantities of gold, but which has not been examined because of the hostility of the native occupants. More than 100 miles to the north-west, at Eersteling, a rich reef was discovered by Button 8 years since, and alluvial gold was obtained as far south as the Komati. So that there is an expanse of 200 miles east and west, and the same distance north and south, in which gold has been discovered by the imperfect mode of search which has thus far been practised. This part of the Transvaal may, therefore, be regarded as presenting great auriferous promise, which, if fulfilled, will probably make it the most prosperous district in the country."

It was recently stated in *The Colonies and India*, that the *Grantully Castle* took home over 10,000*l.* worth of Transvaal gold, and that in the last 6 years over 200,000*l.* worth had been sent through the Cape Commercial Bank alone.

When describing the auriferous rocks of South-east Africa, Dr. Sutherland states that in the Insizwa Mountains, in the basin of the St. John's river along the line of contact of Baines' Dicynodon strata (which there seems to resemble diorite) with the Secondary strata, the former contains various ores of copper, which have been found to yield about 4 dwt. of gold to the ton of ore. The primitive rocks in the valleys where the gold has been found have been very much eroded by the rivers. It would appear to Dr. Sutherland a reasonable assumption that no part of the gold contained in the rocks, that have been eroded and removed in the form of mud and fine sand, has been washed away, but that it remains in the alluvions now traversed by the same rivers. It is obvious that though it may be imperceptibly small in the parent rock, it may be much more abundant in the débris, which constitutes in fact the result of natural stamping operations continued for many centuries.

In the early part of 1874, says R. N. Rubidge, gold was discovered near Smithfield, a newly established town, in the Orange River Sovereignty. This author's account of the geological structure of the auriferous trap dykes in the Dicynodon strata will be referred to in the next chapter.

Keith Johnston says that the Transvaal has gold, discovered in the north of the state by Karl Mauch and Edward Baines, but also existing much farther north, beyond the Limpopo river. Some of those gold-fields, however, have proved very disappointing; while great expectations are (1878) entertained of others discovered in 1872 and 1873 at Maraba Town and Lydenberg, at which gold-digging has been carried on with various success, and where there appears to be sufficient quantity of the precious metal to warrant continuous effort. The gold is here, he says, of excellent quality, commanding as much as 3*l.* 18*s.* per oz. It is mostly alluvial, but nuggets of 4 to 7 lb. weight are sometimes picked up. The most experienced Australian miners are of opinion that extremely rich deposits must yet be brought to light. About 6 leagues distant from Zumbo, at the confluence of the Loangwa with the Zambesi, west of Tete, are the celebrated gold-mines of Parda Pemba, from which much gold was formerly obtained. These are now abandoned, and the village of Zumbo was deserted by the Portuguese for several years, but reoccupied in 1862.

Urua.—According to Keith Johnston, silver and gold are known in Urua, a country on the west of Lake Tanganyika.

Katanga.—Gold is also present in Katanga, west of Lake Moero and south of Tanganyika, in Sekeletu's Dominion. Livingstone heard that the Katanga people are afraid to mine the gold, because Ngolu (which the Arabs translate Satan) has hidden it there. Cameron states that gold is found at Katanga; also in the copper there. He was shown a calabash (holding about a quart) full of nuggets, varying in size from a hazel-nut to swan-shot, obtained in clearing out a water-hole. The natives do not value gold, as it is too soft. When at Benguela, he was told that gold had been found in such a large proportion in the copper brought there from Katanga, that a company was buying all the copper in order to extract the gold from it.

Zanguebar.—The natives of the country of Machanga, on the east coast, south of Zanzibar, brought (1881) rich specimens of gold and copper to Capt. T. L. Phipson-Wybrants. And in 1823, the Arabs informed Capt. Boteler that in some rivers in the vicinity of Mombas, gold in small quantities was at times procured.

Kalahari Desert.—The Kalahari Desert is said to be rich in minerals; Anderson discovered (1879) gold in two mountain ranges.

Madagascar.—Copper and silver are known to exist in Madagascar, and gold, long suspected in some of the ravines of the granitic highlands, has also been discovered. But search for the precious metal is absolutely prohibited by the native laws, lest the inhabitants should be overrun by an influx of foreign diggers. Hence nothing has been done towards developing the mineral resources in this direction.

Ophir.—It would be somewhat out of place to occupy space in this volume with the various and voluminous arguments concerning the claims of certain localities to be considered the site of the Ophir of Scripture. But as it is a subject which may interest some readers, the following list is submitted of the chief publications which deal with it, in addition to the few words on p. 13:—

Sir Roderick Murchison's address to the Royal Geographical Society, in their *Journal*, vol. xxxviii. p. clxxxii. (1868).

Sir R. Murchison in *Proceedings*, Royal Geographical Society, vol. xiii. p. 300 (1868–9).

Livingstone's 'Zambesi,' pp. 2–3.

Smith's 'Bible Dictionary,' art. *Ophir*.

Balfour's 'Cyclopædia of India,' vol. ii. pp. 346–7.

Burton's 'Gold-mines of Midian,' pp. 259–63.

Robinson's 'Theological Dictionary.'

Bickmore's 'Indian Archipelago,' pp. 404–6.

Jacob's 'Precious Metals,' vol. i. p. 2.

Salt's 'Voyage to Abyssinia,' pp. 99–101.

McLeod's 'Travels in East Africa,' vol. i. pp. 211–16, vol. ii. pp. 321–47.

'Notes and Queries,' vols. vii., viii., ix.

Pamphlet entitled 'Ophir: or the Indian Gold-mines,' published by W. J. Johnson, 121 Fleet Street, London, 1880.

Article by Eastwick in the 'Gentleman's Magazine' (July, 1880).

Peacock's pamphlet on the Guinea or Gold Coast of Africa, published by W. Pollard, North Street, Exeter.

Angola.—According to Monteiro, gold-dust had been (1875) discovered in a part of the country called Lombige. [The river Lombige is a small tributary of the Zenza, as the Bengo is called inland.] And at a place called Mayengo, he found two white men with a party of blacks exploring for gold, of which they had already obtained a few c[illegible]es of dust from the sand of the river (Lombige). Some 10 miles f[illegible] on the river is another place where a little gold-dust was procured, but not more than 2 lb. were got after many months' working. The formation of the country from Golungo Alto to the auriferous ground of the Lombige is a hard clay-slate, in which are observed only a few small quartz veins.

WESTERN AFRICA.—With regard to Western Africa generally, the French claim to have imported gold from El Mina (Elmina) as early as 1382. In 1442, Gonçales Baldeza returned from his second voyage to the regions about Bojador, bringing with him the first gold. In 1471, João de Santarem and Pedro Escobar reached a place on the Gold Coast, to which, from the abundance of gold found there, they gave the name of Oro de la Mina, the present Elmina. Leo Africanus says that the King of Ghana had a gold nugget, weighing 30 lb., which was bored through and fitted for a seat. Similarly, in later times, the king of "Buncatoo" had a solid gold stool, which caused his destruction by the Ashantis.

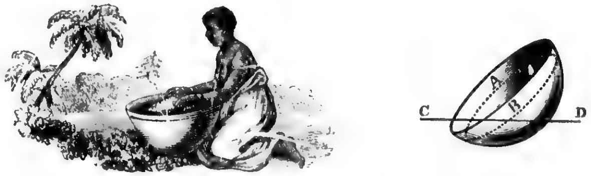
Bosman (letter vi.) says gold is found in three sites. The first and best was "in or between particular hills;" the negroes sank pits there and separated the soil adhering to it. The second "is in, at, and about some rivers." The third is on the sea-shore, near the mouths of rivulets, and the favourite time for washing is after violent night rains. Bosman estimates the annual export at 7000 *marks* per annum. At the conclusion of his 6th letter, he says, "I would refer to any intelligent metallist, whether a vast deal of ore must not of necessity be lost here, from which a great deal of gold might be separated, from want of skill in the metallic art; and not only so, but I firmly believe that large quantities of pure gold are left behind, for the negroes only ignorantly dig at random, without the least knowledge of the veins of the mines."

Some authorities fix the Seecom river as the easternmost boundary where gold is found. This is so far incorrect that Burton panned it from the sands under James Fort. Besides which, it is notorious that on the banks of the upper Volta, about the latitude of the Krobo [Croboe] country, there are extensive deposits, regarded by the people as sacred. The Slave Coast is a low alluvial tract, and appears to be wholly destitute of gold. According to the Rev. Bowen, however, a small quantity has been found in the quartz of Yoruba, north of Abeokuta. The Niger, which flows, according to Burton, from the true auriferous centre, has at times been found to roll down stream-gold. The soil of Fanti and the seaboard is, as has been seen, but slightly auriferous.

Judging from analogy, Burton expects to find the precious metal in the declivities inland and northwards from Cape Palmas, and in that sister formation of the East African ghauts, the "Sierra del Crystal." The late Capt. Lawlin, an American trader, settled on an island at the mouth of the Fernan Vaz, carried to his own country, about the year 1843-4, a quantity of granular gold, which had been brought to him by some country people. He took back all the necessary tools and implements to the Gaboon river, but the natives became alarmed, and he failed to find the spot. Finally, according to the tradition of native travellers, the unexplored region called Rúmá (which may be the "Runga" of our maps, with whose position Rúmá corresponds), and conjecturally placed south of the inhospitable Waday, is a land of goldsmiths, the ore being found in mountainous and well-watered districts.

Mungo Park supplies the amplest notices of gold in the regions visited by him north of the Kong Mountains. The principal places are the head of the Senegal river, and its various influents; Dindiko, where the shafts are most deep, and notched, like a ladder; Shrouda, which gives 2 gr. from every lb. of alluvial matter; Bambouk, and Bambarra. In Kongkadu, the "mountain land," where the hills are of coarse, ruddy granite, composed of red felspar, white quartz, and black shale, containing orbicular concretions, granular gold is found in the quartz, which is broken with hammers; the grains, however, are flat. They vary from a pin's head to the size of a pea, and are remarkably pure. This is called *sana manko* or gold-powder, in contradistinction to *sana birro* or gold-stones, nuggets occasionally weighing 5 drachms. In December, after the harvest home, when the gold-bearing *fiumaras* from the hills have shrunk, the Mansa or Shaykh appoints a day to begin *sana-ku* (gold-washing). The error made by these people is digging and washing for years in the same spot, which proves comparatively unfruitful unless the torrent shifts its course. They never follow the lead to the hills, but content themselves with exploring the heads of the water-courses. The richest yield is from pits sunk in the height of the dry season, near some hill in which gold has been found. The most hopeful formation is held to be a bed of reddish sand, with small dark specks, described as "black matter, resembling gunpowder, called by the natives *sana mira*" or gold-rust; it is possibly emery. The style of panning described by Mungo Park in no way differs from that now practised on the Gold Coast and Kaffir lands. It is illustrated in Fig. 3, and is conducted as follows. A woman puts about ½ to 2 lb. of gravel and sand into the calabash shown, covers it 1 in. deep with water, and crumbles it to pieces and thoroughly mixes it by pulling her hands towards her. She then throws out all large pebbles, taking care not to reject nuggets at the same time; which done, she gives the sand and water a rotatory motion, so as to make a portion fly over the brim of the calabash. While doing this with her right hand, with her left she throws out of the centre of the vortex a portion of sand and water at every revolution. She then adds a little fresh water, and as the quantity of sand has by this time much diminished, holds the calabash obliquely, and makes the sand move slowly round on the line A B, while she constantly agitates it with a quick motion in the direction C D. The whole operation is completed in about 2 minutes.

FIG. 3.



GOLD-PANNING IN WEST AFRICA.

According to Burton, the great centre of West African gold, the source which supplies Manding to the north and Ashanti to the south, is the equatorial range, called the Kong. What the mineral wealth must be there it is impossible to estimate, when nearly 3,500,000*l.* sterling have annually been drawn from a small parallelogram between its southern slopes and the ocean, whilst the other three-fourths of the land (without alluding to the equally rich declivities of the northern versant), have remained as yet unexplored. Even in Northern Liberia gold is found in the streams.

Guinea.—One of the earliest modern travellers to visit the Gold Coast was J. L. Wilson. He describes the gold of Ashanti as being procured both by washing and digging. The soil everywhere in Ashanti seems to be impregnated with gold, and large quantities are obtained from the sand even of the streets of Kumasi [Coomassie]. There are besides very rich mines, and especially in Gaman, where the gold is gathered in large lumps. The mines are very imperfectly worked, and some of the richest are sacred to the native fetishes, and so untouched.

In several parts of the country, as Akim, Dinkira, Tueful, and Wassaw, according to Dr. R. Clarke, gold-digging is (1860) the occupation of large numbers of people, who resort thither from all parts of the settlements.

Apintoe and Essaham are the principal gold-fields in Western Wassaw. At the diggings, marketable goods are sold at greatly enhanced prices, from the difficulty of their transport, in exchange for gold-dust. The yield varies greatly. The metal is procured at some of the "holes" from the auriferous soil, and at others from the crushed quartz. In other districts, it is obtained by washing in the beds of rivers and watercourses after the rains have run off, especially at the base of the hills. At Cape Coast, and along the seaboard, women may be observed washing the sand on the beach, especially after heavy rains. The earnings of these poor women average about 10*d.* sterling daily, but occasionally 2*s.* 6*d.* worth of granular gold rewards their severe toil. To the granules collected on the beach, a fine, black, and apparently metallic sand is often found adhering. The bulk of the gold exported from this part of the coast comes from Ashanti, and the quantity annually sent to England is estimated at 100,000 oz.

After leaving Odoomassie and Akropong, going up to Ahabante, three ranges of mountains are crossed. Capt. Sir John Glover's party (1873) found their great difficulty was to prevent themselves from falling down the gold-pits dug on each side of the road. The natives there have only an idea of sinking a shaft; they have no notion of working a gallery underneath, so that, in the space of a large hall, some 40 shafts would be sunk; they only then remove the soil at the bottom of the shaft, which is capable of simply allowing the body of a man to pass down. He is of opinion that, with the appliances of science, there must be a great deal of gold there yet to be produced. The mountains are entirely composed of quartz and granite. The rivers over which the party passed are all dammed up for the purpose of washing gold; and from Akropong to the river Amoom, the entire line of march is over a country marked by the gold-shafts described.

The Berem river is said to be very rich in gold. After the floods large boulders are washed down, which break when brought into contact with one another; and when the river is low, the natives go down and secure a very large quantity of gold from the boulders which have thus been split open by the force of the current. Coming to Odoomassie, and indeed, from the line of the Prah river to Odoomassie, the gold-pits increase in number, and instead of the shafts being sunk 18 and 28 ft. deep, gold-pits are found like common gravel-pits in England. The steamers from Liverpool reach Accra in 22 days; thence a march of 10 miles across a plain, lands the traveller at an altitude of 1600 ft. Europeans have lived at Akropong for 30, and even 35 years, and Sir John Glover saw children going home for the first time to Europe, 6 and 8 years old, born in these mountains. He therefore finds no drawback to the gold being worked by Europeans. Sir Garnet Wolseley, on the other hand, "would not like to search for gold, the climate being too horrid. Few survive."

Capt. Thompson, who has travelled among the Wassaws, is of opinion that there must be patches of no inconsiderable extent upon the Gold Coast, which exceed in mineral wealth anything that we have known anywhere else in the world. Capt. Butler expresses his belief that if the gold-miners of other and civilized regions had the faintest conception of the nature of the veins of gold which permeate Ashanti, not all the fears of African climate, or of native treachery or cruelty, would prevent an immigration which must ere long completely change the face of these regions, whatever terrible loss of life occurred during the earlier period of settlement. Every little ornament in Coomassie is almost recklessly mended and patched with gold. Common pieces of crockery, which might be perhaps repaired in England by the not very elegant process of sewing in brass wire, are found quite as roughly, or even more roughly, repaired in Coomassie, but with gold instead of brass. Prof. Church analysed some clean fragments of Ashanti gold cut from different nuggets. The sp. gr. was 17·55, and analysis gave:—

Gold	90·055 per cent.
Copper	faint trace.
Iron	trace.
Silver	9·950
	99·945 (?)

The entire country of Akim (between 6° and 7° N. lat., and about 1° W. long.), according to Capt. J. S. Hay, is auriferous in a high degree; the natives, however, are too ignorant and too lazy to work the gold properly, and content themselves with digging circular holes from 16 to 20 ft. deep to obtain it, in the shape of small nuggets and dust, the latter being also found in the rivers and watercourses, where he has seen them washing it. The country is honeycombed in some parts with these gold-holes, which make walking a difficult and sometimes dangerous operation. The soil is a heavy, tenacious red clay, quartz strata and red sandstone cropping up in every direction.

The most detailed account of the Wassaw diggings is given by J. A. Skertchley, who, early in March of 1877, arrived at Cape Coast Castle in command of an expedition whose object was to "inspect the gold-mines of Wassaw (between 5° 10′ and 5° 40′ N. lat., and between 1° 25′ and 2° 20′ W. long.), one of the late subjugated districts of Ashanti."

Several English and foreign expeditions had previously been fitted out for a similar purpose, in the hope of establishing a gold-mining company, in order to reap a portion of that rich auriferous harvest a few ears of which were being culled by the native miners. From one cause or another, all these expeditions failed, a principal reason being the attempt to form a mining company upon a plan similar to that on which companies are based in Australia, California, and other civilized portions of the globe. In Africa, however, are difficulties to contend with which are not encountered elsewhere. A climate enervating in the extreme, and which speedily finds out the weak spots in a European constitution; want of means of transport; a lack of food suitable to Europeans; and lastly, the innate and universal laziness of the natives—all these difficulties have to be met and overcome, rendering the task by no means easy. Still Skertchley determined to ascertain the practicability of Europeans working the mines of the Gold Coast, not by their own personal labour, as was attempted by the French and Dutch, but under their supervision. On the Western Coast of Africa, however energetic a man may naturally be, the enervating character of the climate is such as to take all the "go" out of the greatest enthusiast in a few months, while it would be impossible for any white man to work day by day in a similar manner to our navvies and miners.

At the time of the arrival of the expedition at Tacquah, there were upwards of 6000 men and women engaged in working the gold. The auriferous mineral is found in a series of parallel reefs, descending at about the angle of 45°, encased by walls of hard quartz and pseudo-quartz of a ruddy, greasy look. These reefs have been worked from very early times, the country for miles around being honeycombed with holes and washing-pits. Of geology and mineralogy, the natives have not the slightest idea, since the party continually came across shafts put down in the most absurd positions. Indeed, it required a very sharp eye to detect the deserted shafts in many places, for they were sunk close alongside the path, or, indeed, in the old pathway itself, so that one had to travel by a series of zigzags between the pits. These shafts are quite curiosities in themselves, being in some cases as much as 80 ft. deep, and about 2 ft. in diameter, sunk as straight as if they had been bored with a huge auger; and in not one of them was there a single stick of timbering. The mouths of the old shafts were in many cases covered loosely with fallen branches or leaves, so that the unwary traveller stepping upon them would suddenly find himself precipitated to the bottom, or, as was generally the case, into the accumulated water, which, in some cases, rose to within a few feet of the surface.

The shafts are dug by means of a small hoe, shaped somewhat like an Indian *bassoolah*, the iron being about 2 in. broad and 4 or 6 in. long. The workman squats on his hams, and scrapes the sandy earth into a small calabash, which, when filled, is drawn up to the surface by his companions. The shaft is just large enough to allow the miner to turn round in, and means of ascent and descent are afforded by holes cut in the sides, into which the miner inserts his toes, after the fashion of the old chimney-sweepers' boys when ascending a chimney. Having no pumps, and baling, except on a very small scale, being impossible, operations have to be suspended as soon as water is reached; and indeed but little can be done at all during and shortly after the rainy season. In alluvial ground, the gold is found in and beneath a stratum of blue clay, resting upon a substratum of hard rock, or in a layer of gravel. In some districts, all the sandy gravel below the surface soil is auriferous.

Where reefs are worked, they have either been struck by sheer luck when sinking a shaft, or are outcropping reefs worked downwards from the surface to water-level. The latter is the case at Tacquah, where the strike of the reefs runs along the side of a hill, dipping towards the west at an angle of about 45°. The head- and foot-walls are composed of syenite, as hard as flint, through which the natives are unable to penetrate, so that, unless the reef itself is wide enough to allow a man to work in it with elbow-room on each side, they can do nothing with it. The shafts run down with the reef at an angle of 45°, and at Tacquah are about 40 ft. deep. The tools employed are hammers, generally of European manufacture, about 2 lb. in weight, and chisels made by native blacksmiths from the commonest bar-iron, tempered hap-hazard by being plunged into cold water. Others use chisels fixed into wooden handles like gouges. With these rude implements, aided by the light of a palm-oil lamp, with a piece of rag for wick, they work in gangs of two or three day and night. At Tacquah, there are rude ladders constructed of bamboo as means of access, and the mouths of the shafts are covered with a shed.

a rock. compo-
:osed of Quartz
Hornblende
and mica

By working all day, two men can cut out about a cubic foot of the reef. The quartz is placed in a calabash, which is tied in a handkerchief, and sent up to the workman at the surface. These convey it to their homes, and set about the process of pounding it with hammers until it is reduced to powder. This, again, is placed on a slab of syenite or granite about 2 ft. square, resting at an angle sloping from the operator on a crutch of three sticks, held together by what sailors would term a "grommet" of rope. A handful of the pounded stone is placed upon the slab, and rubbed fine with a stone shaped liked a baker's roll, to which a slight rotatory motion is communicated as it is worked backwards and forwards on the slab. The ground quartz is caught in a calabash placed at the lower edge of the large slab, and, as a rule, it takes the whole night to grind down a cubic foot of stone, it being the custom for the miners performing this branch of labour to work all night, enlivening the time with songs and frequent potations of trade gin. The accumulated dust is swept together, and the floor is carefully gone over, so that every particle of the auriferous quartz is gathered up; and each 3 months or so, the floor of the grinding-shed is hoed-up and washed or "panned" off.

The ground quartz is handed over to the wives of the operators, who invariably perform the operation of washing, and not unfrequently that of grinding too; and during the whole of his stay in Wassaw, Skertchley never saw a male washing the dust, although female children of 6 or 7 years of age not unfrequently engage in the work. The implements consist of a large wooden bowl about 3 ft. in diameter, cut out of the solid; one or two similar but smaller bowls; a few feathers, a few calabashes, and a shell or two of the large edible snail.

Taking their stand knee-deep in the creek or one of the numerous water-holes on its banks, the women place a handful or two of the dust in one of the smaller bowls, dip it under water, and pick out any large pieces which appear to contain gold, and which have escaped grinding. The residue is then washed, with exactly the same oscillatory motion as the Australian miners apply to their prospecting dishes, the bowl being held above the larger one, which floats on the stream beneath, and is prevented from drifting away by the knees of the operator. As the bowl is rocked from side to side, the lighter particles separate from the heavier, and are, after being carefully inspected, thrown on one side. This process continues until nothing is left in the large bowl except a mass of black sand, amongst which a few grains of gold sparkle in the sunlight. This washed sand is then placed in one of the calabashes and subjected to a very careful washing, the calabash being rocked over a larger one, and this again over the largest, so as to catch every particle which might run over the edge. Gradually the amount is reduced until a thin line of auriferous particles is seen glittering along the upper end of the sand; this is picked out with the feather, and washed in a still smaller calabash, until the dust is cleared of every particle of black sand. The gold is then carefully brushed into the snail-shell with the feather, and thus the operation continues until the whole mass of rock is washed over. Each woman, as a rule, takes her stand in a particular hole; and when the washing has continued for some weeks, the water is bowled out of the hole, and the mud at the bottom is panned off.

The results vary considerably. The gold is so exceedingly fine, that in spite of all their care, and the expenditure of unlimited time and patience, the washers lose a very large percentage. Taking a fair average, it may be said that cutting out will occupy one day, crushing a second, and washing two more—four days in all; the return may be 3 dwt., to be divided amongst 4 miners and 4 washers.

The reefs belong to the king or to chiefs, who receive or are supposed to receive one-half of the stone cut out; but in most cases, when any stone is given as royalty, the miner takes particular care to pay the landlord in stone either utterly barren or from the least auriferous portion of the reef. The discovery of a pocket is the signal for a general debauch among the lucky finders and their friends; so that, as a rule, they are poorer after their rejoicing than before, for gin costs 4*s.* 6*d.* a bottle at Tacquah, and he is a very poor miner who cannot put away a bottle on his own account before total insensibility deprives him of the power of swallowing. All large nuggets are the perquisites of the king; but these are seldom found, or, if found, are broken up so as to avoid the claim.

The miners come in the dry season to Wassaw from all parts of the Gold Coast, and even as far as Monrovia and Lagos; while many arrive from the interior. What becomes of the gold-dust is more than Skertchley is able to say; but it is certain that the quantity which makes its way down to the European factories is no criterion of the quantity raised. A large percentage is buried in the floors of the huts of the miners, who like to accumulate the precious dust in this manner, though its acquisition is of no more real use to them than are the hoards of the miser. It is true the natives have but few wants to supply—gin, cloth, tobacco, and powder being their principal articles of purchase; but it is strange that after the severe toil of the mines, they should be content to bury the gold in jars in the floor of the huts during their lifetime, while at the death of the owner the precious metal is interred with him. A "resurrectionist" would be a lucrative profession in West Africa, for there are millions of pounds' worth of gold buried in the graves of the chiefs and principal men, who had lived from hand to mouth in apparent penury.

The gold is worth, as it comes from the mines, about 3*l.* 17*s.* 6*d.* per oz.; but it must not be supposed that it would pay anyone to go there to purchase it, for the "simple" natives are as well up in the art of sophistication as their lighter-hued brethren.

Most of the hill ranges in Wassaw are quartzose, more so towards the north, those to the south being basaltic. All transport has to be effected on the heads of men and women, and roads are conspicuously absent. The rainfall is very heavy at certain seasons, and altogether wanting at others; thus an extensive system of reservoirs and conduits would be necessary to allow of any but irregular work. The country is peopled by a race whose laziness is only equalled by their mendacity, and who, despite their richness in gold, are miserably poor both as regards clothes and food. They are so superstitious as to believe that gold will run away from a man who has boots on; that if a man works on the king's birthdays (a weekly institution), he will obtain no gold; that if his lamp goes out, he must do no more work on that day; and that gold moves about under the ground, and can only be found by a select few. The problem for Anglo-Guinea gold-mining companies to solve, is how to replace the useless native by an efficient labourer who can stand the climate and food.

The exports of gold in men-of-war from Guinea, according to the books of the English-African Company, were in :—

1808-1814	.. .. ..	51,569 oz.,	value	205,344*l.*
1815-1818	.. .. ..	30,336	,,	125,380*l.*
Total	.. ..	81,905	,,	330,724*l.*

The declared exports from British Possessions on the West Coast of Africa have been approximately as follows :—

1858-1860	.. ..	100,000*l.*	in value,	or about	1584 lb.	fine gold.
1861-1865	.. ..	20,400	,,	,,	328	,,
1866-1870	.. ..	27,800	,,	,,	449	,,
1871-1875	.. ..	38,700	,,	,,	622½	,,

The total exports from the West Coast, as given approximately in British commercial returns, are :—

1858-1860	.. ..	99,600*l.*	in value,	or about	1610½ lb.	fine gold.
1861-1865	.. ..	91,000	,,	,,	1467½	,,
1866-1870	.. ..	120,000	,,	,,	1936	,,
1871-1875	.. ..	115,500	,,	,,	1852½	,,

Since the preceding remarks were in type, and too late for incorporation in them, have appeared papers on the subject of their recent journeys to the Gold Coast by Capt. Cameron and Capt. Burton, published in the 'Society of Arts Journal,' vol. xxx., No. 1541, pp. 777–794, and the 'Proceedings of the Royal Geographical Society,' vol. iv.

Soudan.—Portions of Senegambia, as the Kong Mountains (in Manding) and Bambouk, are historically renowned for their gold-diggings.

In Bambouk province, gold is said to be so common and accessible that the rudest methods of collection are deemed sufficient. The most remarkable deposit is at Natakoo, where a considerable hill seems to be wholly composed of auriferous strata. There is also a good mine at Kenieba.

According to Mungo Park, the gold of Manding is never found in the matrix or vein, but always in small grains, scattered through sand or clay. When the streams have subsided, a day is appointed by the chief, and the people dig in the streams. But the most profitable mode of washing is in the dry season, by digging a deep pit, near some hill which has been previously discovered to contain gold. In general, when they come to a stratum of fine reddish sand, with small black specks, they find gold in some proportion or other. The gold is sometimes met with in a brown-coloured clay. During his stay at Kamalia, the gold collected by the traders, for salt alone, was nearly 198*l.* sterling, and as Kamalia is a little town, this quantity must bear but a very small proportion to the quantity collected in the district.

Between Senegal and the Niger, the following localities are mentioned by various authorities as producing gold:—Sego (about 12° 25′ N. lat., and 7° W. long.); Buria (Bouré or Buré), in the Mandingo Country, Upper Niger (9° W., 11° 30′ N.), where, out of a population of 6000, about one-sixth are engaged in gold-washing for some months in the year; Kuma-Khana (between Buria and Bofoulaba, at the junction of the Bafing and Bakhoy, E. Bambouk), where are a large number of diggings; Sangara (at the sources of the Niger); and Serankules.

In 1867, R. A. Parrish, of Philadelphia, U.S., petitioned (Amer. Jl. Min., ii. 337) the House of Representatives, asking its intervention in a case of alleged spoliation by the French Government, amounting to 15 millions of francs. The claim rests upon the personal parole of the Emperor given to the petitioner at an extraordinary audience appointed for the purpose, and was to have been embodied in a treaty, of which, together with all his other interests, he says he has been fraudulently deprived. The sum above named was promised for the claimant's demonstration of auriferous territory similar to that of California, since conquered and annexed to France, situated on the Kong Mountains of Africa, on the western coast, "and from which the Government of France has already derived great mineral wealth, her gold coinage for many years since then having attained the unprecedented sum of more than 100 millions of dollars annually."

Writing in 1881, Mitchinson says that the district of Senegambia is rich in minerals, especially gold, and to work the latter, attempts have been made for more than a century by the French to obtain a profitable share in working the mines; but factories formerly existing at Sansanding, and other places, met with but little success. These failures are, however, fully accounted for by the misconduct and mistakes of the managers and agents, or by wars and accidental misfortunes, rather than risks inseparable from the business. The manager of the first gold company, a rapacious, cruel, and unjust administrator, lost his life at St. Joseph, a victim to the vengeance of the long oppressed natives. The greatest obstacle to success was the instability of life of the agents, who frequently had destroyed both character and constitution in Europe, and accepted their positions in the distant African Colony as a species of honourable

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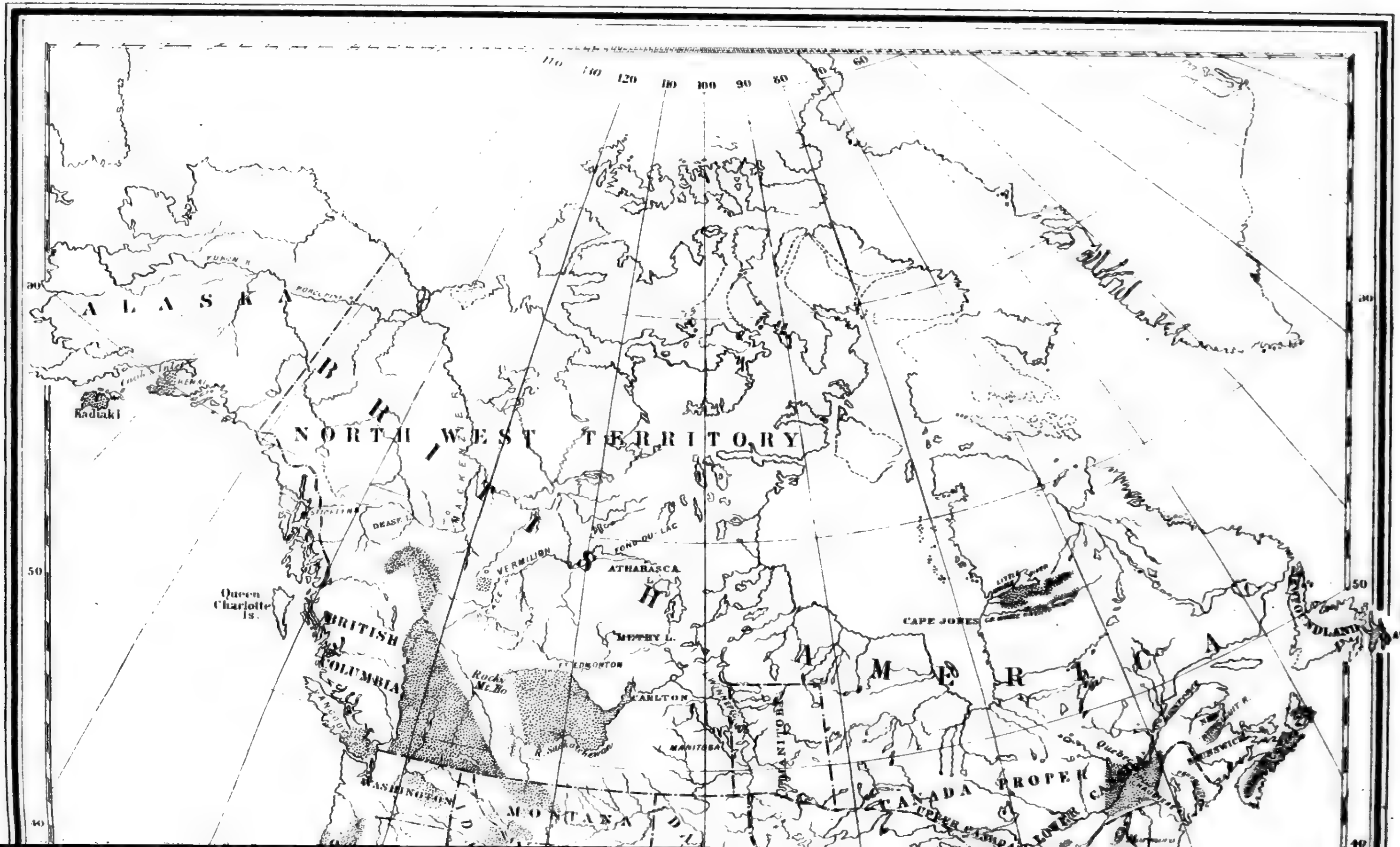
GLOWING [illegible]

OF PORTUGUESE WEST AFRICA

CAPETOWN, Monday. (Reuter.) A tleman, recently arrived from Portu ese West Africa, in which he made an tended tour, informs the "Argus" at very rich deposits on an extensive ale have been located there, occurring ng and underneath the beds of rivers. ey average 7 dwts. per cubic yard, and, parts, reach as high as 10 ounces per bic yard. The expense of working by dinary sluicing methods, he computes 3s. per cubic yard, which, by introducg hydraulic processes, would be reduced 6d. The country is very fertile and ll watered, and the natives peaceable and od workers. Great rubber fields also st, and cotton in abundance. Goldaring reefs have also been located in rious parts, which, he believes, will timately rival the Rand. Game teems. ere are elephants in enormous troops, the so-called extinct quagga is also nd there.

e further stated that there was good und for believing that the arbitration oceedings, which are now in progress, the delimitation of the eastern frontier this territory will result in the moving the limit of British territory much further westward, the twentieth degree of ngitude being probably fixed upon by the ng of Italy, who is the arbitrator, on ground that Lewanika's influence has tended as far as the railway, from one the ports on this coast to Lobale.

THE REFORMING SICKLE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FT. EDMONTON
CARLTON
Rocky Mt. Ho.
R. Saskatchewan
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AMERICA
Queen Charlotte Is.
BRITISH COLUMBIA
WASHINGTON
MONTANA
CAPE JONES
CANADA PROPER
UPPER CANADA
LOWER CANADA
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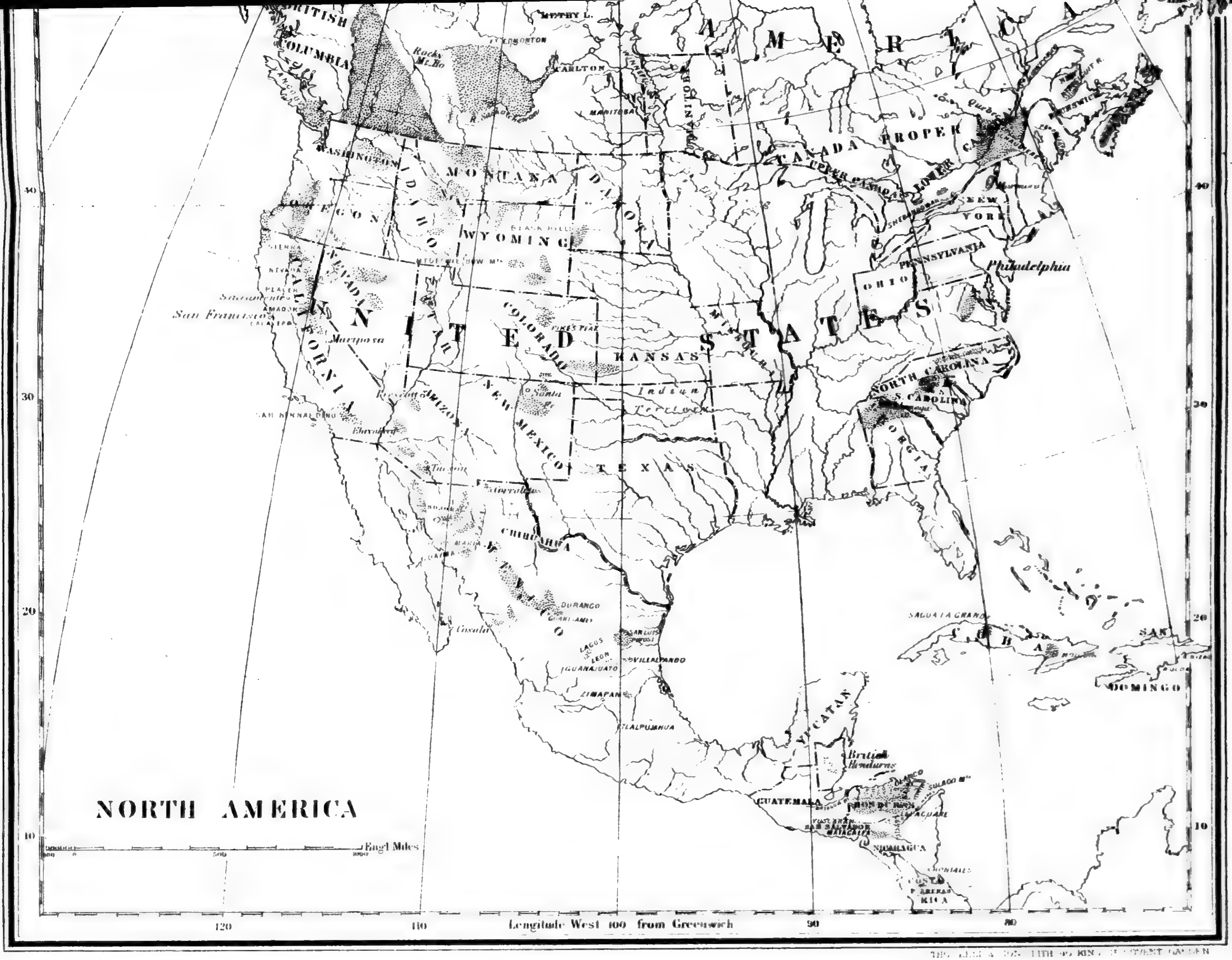
NORTH AMERICA



THE [illegible] & [illegible] LITH [illegible] KING [illegible] COVENT GARDEN

exile. In spite of such failures, there is every reason to believe that, with modern machinery and science, splendid results might be anticipated.

The Venetian traveller Cadamosto, who visited Western Africa about 1454, alludes to the gold-field of Timbuctoo (spelt Tombutto, Tambucutu, Tumbutum, Timbuktu, &c.), and declares that the gold coinage of Portugal, Spain, and Italy, in the 14th and 15th centuries, was entirely supported by supplies from this region. Most of the gold then exported from the Soudan would seem to have found its way by the slave and ivory caravans to the Mediterranean ports of Tunis, Fez, and Morocco. The large unwalled town of Gyni, in the kingdom of Melli, is specified as a headquarters for the exchange of gold and salt.

AMERICA, NORTH.

ALASKA.—Gold and silver occur, says Dall (1870), in limited quantities in Alaska. Talcose and chloritic slate, with veins of quartz, abound in the island of Kadiák. An analysis of specimens of these rocks, by Dr. Newberry, shows only about $1 (4*s.* 2*d.*) per ton of value in gold and silver. He says in regard to them, however, "These specimens come from a system which at other points is probably much richer. The mineralogical character of the specimens is precisely that of the most productive gold-bearing veins known, although silver will not be found in quantity in such an association of minerals."

It is not impossible that the gold-bearing alluvium of Cook's Inlet, first examined by Doróshin, was originally derived from similar rocks, especially as the island of Kadiák is apparently a prolongation of the peninsula of Kenái, on which the gold-bearing alluvium was found. Another analysis of this quartz, by Dr. John Hewston, jun., afforded $4 15c. in silver per 2000 lb., with a trace of gold. These specimens were associated with sulphurets of lead and iron.

The gold-deposits of the Stickeen [Stikine] River are all situated in British territory. They are only worked in the placers, but gold is said to exist in quartz veins in the vicinity. The head-waters of the Táhco River have afforded coarse gold to the few enterprising miners who have penetrated there. Fine scaly gold, like iron filings, in very small quantities, is found in the sands at the mouth of the Porcupine or Rat River, the branch which runs into the Yukon from the north near Fort Yukon; but there is scarcely a "colour" to the pan, and the country is accessible only for 3 months in the year. The alluvium of the Kaknu River is a yellowish clay, and has not yet been worked by any practical miner. Gold has been found in the bay on which the Taku villages are situated, and in the streams of the vicinity. It averages 5 c. (2½*d.*) to the pan, in scales or small nuggets. The richest deposit was on the main stream, 4 or 5 miles from the bay, at the foot of a waterfall, said to be 100 ft.

high. More recently, quartz prospecting has been vigorously carried on here, and quantities of samples of the auriferous mineral have been taken to San Francisco for examination.

BRITISH AMERICA.—The British territory in North America is now included under Canada and Newfoundland, the latter being the only province which refused to join the confederacy; but, for the purposes of reference, it will be more convenient to recognise certain subdivisions, as follows:—British Columbia, Canada proper, Manitoba and the North-West Territory (formerly Hudson's Bay Territory), New Brunswick, Newfoundland, and Nova Scotia.

British Columbia.—To use the words of George M. Dawson, whose several invaluable reports form the principal source of information on this head, and will be liberally drawn upon, "it may be said, without exaggeration, that there is scarcely a stream of any importance in the province of British Columbia in which the 'colour' of gold cannot be found." The gold discoveries, made known in 1858, led to a great influx of miners in that and the following year; and gold, the first cause in attracting attention to the country, has ever since been the chief factor in its prosperity. See sketch map, Fig. 4.

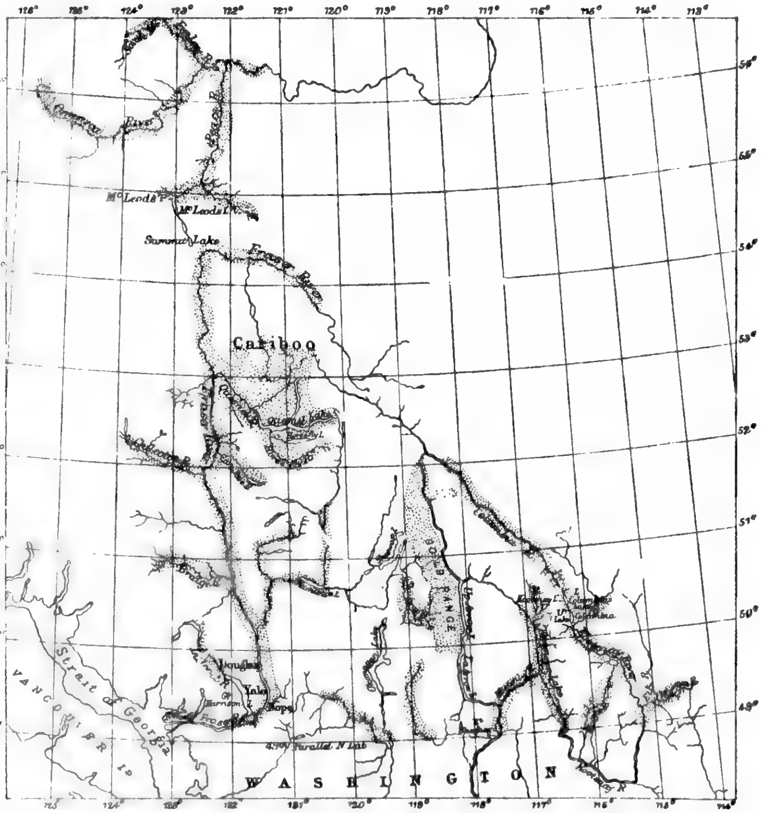
The annexed table shows the actually known and estimated yield of gold, the number of miners employed, and their average earnings per man, per year, from 1858 to 1880:—

Year.	Amount actually known to have been exported by Banks, &c.	Add one-third more, estimate of gold carried away in private hands.	Total.	Number of Miners employed.	Average yearly earnings per man.
	$	$	$		$
1858 (6 months)	390,265	130,088	520,353	3,000	173
1859	1,211,304	403,768	1,615,072	4,000	403
1860	1,671,410	557,133	2,228,543	4,400	506
1861	1,999,589	666,529	2,666,118	4,200	634
1862	3,184,700	1,061,566	4,246,266	4,100	517
1863				4,400	482
1864	2,801,888	933,962	3,735,850	4,400	849
1865	2,618.404	872,801	3,491,205	4,294	813
1866	1,996,580	665,526	2,662,106	2,982	893
1867	1,860,651	620,217	2,480,868	3,044	814
1868	1,779,729	593,243	2,372,972	2,390	992
1869	1,331,234	443,744	1,774,978	2,369	749
1870	1,002,717	334,239	1,336,956	2,348	569
1871	1,349,580	449,860	1,799,440	2,450	734
1872	1,208,229	402,743	1,610,972	2,400	671
1873	979,312	320,437	1,305,749	2,300	567
1874	1,383,464	461,154	1,844,618	2,868	643
1875	1,856.178	618,726	2,474,904	2,024	1,222
1876	1,339,986	446,662	1,786,648	2,282	783
1877	1,206,136	402,046	1,608,182	1,960	820
1878	1,062.670	one-fifth 212,534	1,275,204	1,883	677
1879	1,075,049	,, 215,009	1,290,058	2,124	607
1880	844,856	,, 168,971	1,013,827	1,955	518
			45,140,889		

The dollar is equivalent to about 4*s.* 2*d.*, thus the total value of the gold-export from this colony has amounted to something like 9,028,178*l.*

The gold-yield shows a fluctuation from year to year, which is due not only to the uncertainty of the deposits worked, and number of miners employed, but depends also on climatic conditions. Thus the

FIG. 4.



SKETCH-MAP OF BRITISH COLUMBIAN GOLD-FIELDS.

decrease of 1876, as compared with 1875, may be attributed in the Cariboo district to the great quantity of snow falling on the mountains during the preceding winter, and more than average rainfall of the summer, circumstances which prevented the clearing of the deep claims from water till late in the season. In Cassiar, the unfavourable spring prevented the miners from reaching their claims till late, and heavy floods impeded their operations during the summer.

The very general distribution of alluvial gold over the province may indicate that several different rock formations produce it in greater or less quantity; though it is only where "coarse" or "heavy" gold occurs that the original auriferous veins must be supposed to exist in the immediate vicinity of the deposit. "Colours," as the finer particles of gold are called, travel far along the beds of the rapid rivers before they are reduced by attrition to invisible shreds; and the northern and other systems of distribution of drift material have, no doubt, also assisted in spreading the fine gold. The gold formation proper, however, consists of a series of talcose and chloritic, blackish or greenish-grey slates or schists, which occasionally become micaceous, and generally show evidence of greater metamorphism than the gold-bearing slates of California. Their precise geological horizon is not yet determined, no geological survey to that end having been made; but Dawson is inclined to believe that they will be found to occupy a position intermediate between the more distinctive members of the Lower Cache Creek group of Selwyn's first provisional classification of the rocks of British Columbia (Rep. Prog. Geol. Survey, 1871-72, p. 61), and the base of the overlying Mesozoic rocks, called in Dawson's report for 1875 the Porphyrite series. If this be so, they are not improbably the geological equivalents of some of the richest auriferous rocks of California. By the denudation of the auriferous veins traversing these rocks, the gold has been concentrated in the placers.

The greatest areas of these rocks appear in connection with the disturbed region lying west of the Rocky Mountain Range, known in various parts of its length as the Purcell, Selkirk, Columbia, Cariboo, and Omineca Ranges. Other considerable belts of auriferous rocks, however, probably belonging to the same age, occur beyond this region, as in the vicinity of Anderson River and Boston Bar, on the Fraser; at Leech River, Vancouver Island, and elsewhere.

The Cariboo district, discovered in 1860, has been the most permanent and productive. The 53rd parallel of latitude passes through the centre of the district, which has been described as a mountainous region, but is rather to be regarded as the remnant of a great high-level plateau, with an average elevation of 5000 to 5500 ft., dissected by innumerable streams, which flow from it in every direction, but all eventually reach branches of the Fraser River. These streams, falling rapidly about their sources over rocky beds, descend into great V-shaped valleys; and, with the lessening slope, the rock becomes concealed by gravel deposits, which increase in thickness and extent till the valleys become U-shaped or flat-bottomed, and little swampy glades are formed, through which the stream flows tortuously and with gentle current. The steep sloping banks of the valleys are densely covered with coniferous forest, of which comparatively little has been destroyed by fire, owing to the dampness of the climate at this great altitude. The surface of the broken plateau above is often diversified by open tracts, affording good pasture in summer; and the whole country is more or less thickly covered by drift or detrital matter, concealing the greater part of the surface of the rocky substratum.

As in all new gold-mining districts, the shallower placer deposits, and gravels in the present stream-courses, first attracted attention; but, with the experience of California and Australia, it was not long before the "deep diggings" were found to be by far the most profitable. Williams' and Lightning Creeks have, so far, yielded the greater part of the gold of Cariboo. They were known from the first to be rich, but have been found specially suited for deep work, in having a hard deposit of boulder clay beneath the beds of the present water-courses, which prevents the access of much of the superficial water to the workings below. By regular mining operations, the rocky bottom of the valley is followed beneath 50 to 150 ft. of overlying clays and gravels, the course of the ancient stream being traceable by the polished rocks of its bed, and the coarse gravel and boulders which have filled its channel. In the hollow of the rocky channel, the richest "lead" of gold is usually found; but in following the rock surface laterally, side-ground, rich enough to pay well, is generally discovered for a greater or less width. The old stream-courses of the Cariboo district are found to have pursued very much the same directions as their present representatives follow, crossing often from side to side of the valley with different flexures, and occasionally running through below a point of drift material projecting into the modern channel, but never actually leaving the old valley, or running across the modern drainage system, as is so often the case in the deep placers of California and Australia.

As an example of the methods employed, and extent of mining operations required to reach the buried channels, the Van Winkle Mine on Lightning Creek, which is the most successful now in operation, may be taken. This claim covers about 2050 ft. in length of the valley, the deepest part of the old channel of which had been cleared out to a length of 1600 to 1700 ft., in October of 1876. Much side-ground, however, yet remains; and the workings sometimes attain a width of 200 to 300 ft., in following this up as far as it can be made to pay. The claim yielded the first dividend in December, 1873, $40,000 (8000*l.*) having been expended before gold was found in the channel. It has since continued to pay handsomely, having produced in one week gold worth $15,700 (3140*l.*), and on other occasions at the weekly "clean up," sums of $14,000 (2800*l.*), $12,000 (2400*l.*), &c. At the date above mentioned, the total product of gold had amounted to $500,964 (100,193*l.*).

In reaching the buried channel, a shaft is usually sunk at the lower or down-stream end of the claim, on the sloping side of the valley, where, after having gone through a moderate depth of clay or gravel, the slaty rock of the district is reached. The shaft is then continued through this till a depth supposed to be sufficient is attained, when a drift is started at right-angles to the course of the valley ; and if the right depth has been chosen, either by rough estimation or calculation based on that required in other neighbouring workings, the old channel is struck in such a way as to enable the subterranean water, collecting in it from the whole upper part of the claim, to be pumped to the surface by the shaft. On cutting out of the slate rock, however, into the gravel, so much water is frequently met with that the pumps are mastered, rendering necessary a cessation of work till the dryest part of the season, or the application of more powerful machinery. When the drift is not found to be at a sufficient depth to cut the bottom of the old channel, it is generally necessary to close it, and after continuing the shaft to a greater depth, to drive out again. The old channel, once reached and cleared of water, is followed up its slope by the workings, to the upper part of the claim, and where paying side-ground occurs it is also opened.

In the Van Winkle mine, the average depth of the workings is only about 70 ft., the lowest shaft being placed 300 ft. from the creek, on the opposite side of which the rock is seen to rise to the surface, forming steep cliffs. The water is raised to within 40 ft. of the surface, when it is discharged into an adit 3000 ft. long, which is also used by other claims. There are two pumps, 10 in. diameter, with wooden pipes, making about 12 4-foot strokes a minute, the power being supplied by an 18-foot breast-wheel. This does not adequately represent the volume of water pumped, however, as the ground of this claim is partly drained by others lower in the series, in which work cannot be carried on till later in the season. The richest pay is obtained in the rock channel of the old stream, but where this is much contracted, the force of the water has swept the gold away to those places where its width is increased. The harder rocks still preserve their polished water-worn forms, but most of the slates are rotten and crumbling to a considerable depth, and in cleaning up in the bottom, a thickness of 1 to 2 ft. is taken out with a pick and shovel, and sent up to the surface with the overlying gravel, for treatment. In the side-work, as in the central channel, the greater part of the gold is found lying directly on the "bed-rock," and only occasionally are paying streaks seen in the gravel a few feet above it. The side ground is worked up from the channel in successive breasts parallel to it. The average yield of the part being worked at the time of Dawson's visit may be stated at 2½ or 3 oz. to each set of timber, the set uncovering about 35 sq. ft. of bed-rock, with a height of 6 ft.

The lowest layers of gravel contain many larger boulders of quartz, and slaty fragments, not much water-worn, which must have come down from the hill-sides; the appearance is that of deposit by torrential waters to a depth of 4 to 6 ft. in the channel, above which the gravel is generally better rounded, and more evenly spread though still mixed with clay.

In consequence of the unconsolidated nature of the gravel, the pressure on the supports of the workings is excessive. The sets of timber are in some places only a few inches apart, and the whole of the workings are lined with complete lagging. The timber used is very massive, being 1 to 2 ft. in average thickness, and consisting of the spruce of the country, simply barked and sawn into lengths. It costs, delivered at the mine, 8 c. (4*d.*) per running foot, all suitable sizes being taken at the same rate. The lagging, which is merely split out, 4 ft. long, 5 in. wide, and 2 in. thick, costs $7 (29*s.*) per 100 pieces. With every precaution, the timbers are frequently crushed by the pressure, or the uprights even forced downward into the slate. Where large boulders are removed from the sides, or "slum" is found, spruce brush requires to be extensively used behind the lagging, and in many parts of the mine the water streams from the roof like a heavy shower of rain.

The auriferous gravel is raised to the surface by bucket and rope, with friction-gearing and water-power. The whole of the deep workings are annually filled with water at the time of the spring floods, and it is sometimes late in the summer or autumn before the pumps again acquire the mastery. In October of 1876, the quantity of water being raised amounted to about 13,870 gal. a minute, or 19,972,800 per diem.

On Lightning Creek, about 16,000 ft. of the valley may be said (1876) to be worked out, in so far as the deep channel is concerned; and though some bench claims and tributary creeks have paid well, the material on the sides of the valley is not rich enough to pay for hydraulic work at present. In endeavouring to "bottom" the old channel further down the valley, very great difficulties are encountered, owing to the large quantity of water met with, and the increased depth of the sinking required. There is no reason to believe, however, that the lowest part of the channel holding good pay has been reached.

The following table, supplied by James Evans to the Minister of Mines of British Columbia, gives as correct a statement as he has been able to compile of the amount of money taken from some of the more prominent claims on Lightning Creek, up to November 1st, 1875:—

Dutch and Siegel (now Perseverance)	$130,000 (26,000*l.*)
Dunbar	30,000 (6,000*l.*)
Discovery and Butcher	120,000 (24,000*l.*)

Campbell and Whitehall	$200,000 (40,000*l.*)
South Wales	141,531 (28,306*l.*)
Lightning	153,962 (30,792*l.*)
Point	136,625 (27,325*l.*)
Spruce	99,908 (19,981*l.*)
Costello	20,476 (4,095*l.*)
Vulcan	56,955 (11,391*l.*)
Vancouver	274,190 (54,838*l.*)
Victoria	451,642 (90,328*l.*)
Van Winkle	363,983 (72,796*l.*)

On Williams' Creek, on which the towns of Barkerville and Richfield are situated, the chief workings have been in a space of about 2¾ miles in length. In this, the deep channel has been worked through; also as much of the side ground as would pay at the time at which the mining took place. Many of the lateral creeks and gullies here have paid remarkably well; and the hill sides, in some places, to a height of 100 ft. or more, have proved to be sufficiently rich for the hydraulic method of working, which is now extensively practised. Williams' Creek, however, will not compare with Lightning Creek in richness, its yield in 1875 being, according to Bowren's estimate, only $68,000 (13,600*l.*). Barkerville, however, has a certain importance in being the centre of a number of outlying mining districts.

The cañon between Barkerville and Richfield divides the creek into two parts. For about ½ mile above it, the ground was shallow, and has been worked open to the bed-rock. Further up, deep drifting was practised in former years; hydraulic work is now carried on. Below the cañon, all the work has been deep, in the old channel. Though streaks of "pay" were sometimes found after getting down about 20 ft., these were usually disregarded in early days. In the Cameron claim, however, ½ mile below Barkerville, the dirt paid nearly to the surface, and was worked in stages from below after the old channel had been cleared out. The workings were about 60 ft. deep at Barkerville, only 35 ft. at the former site of Cameronton, and at the Ballarat claim,—¾ mile below Barkerville,—80 ft. This is the lowest claim in which the old channel has been bottomed, and most of the gold obtained was light and scaly. The valley is here wide, the present stream turning abruptly to the west; while a wide, low hollow, known as Pleasant Valley, runs off in the opposite direction, to Antler Creek. It is supposed by many that the main channel of the ancient watercourse turns in this direction; but owing to the great quantity of water, and loose character of the ground, neither this nor the present valley of Williams' Creek, below the Ballarat, has yet (1876) been proved, though much money has been expended in the attempt. The Lane and Kurtz Company imported expensive machinery and erected some very complete works some years ago, but have not succeeded in proving their ground, and have, for the present, abandoned the attempt. As some of the tributary streams have paid well, there is reason to believe that a portion, if not the whole, of the deep channel of the lower part of Williams' Creek must be rich, notwithstanding the generally fine character of the gold in the Ballarat mine.

As already stated, Lightning and Williams' Creeks have been specially favourable ones for deep working, but even in these it has often been barely possible, with the appliances which can at present be obtained, to bottom many parts of their upper reaches, while the more difficult lower portions of the channels have not been proved in either case.

Owing to the isolation of the district, and length and character of the road by which it is reached, the price of food—the whole of which is imported—and of labour is excessively high. The average rate of freight from Yale—the head of navigation on the Fraser—to Barkerville, according to Bowren, is 7½c. to 8c. (3¾*d.* to 4*d.*) per lb. in spring, and about 12½c. (6¼*d.*) in autumn; or it may be said to average 9c. (4½*d.*) a lb., or 42*s.* a cwt.,—a heavy tax on weighty articles.

The prices current of staple articles in Cariboo are as follows:—

Flour, per lb.	8*c.* (4*d.*)
Beans ,,	15*c.* (7½*d.*)
Bacon ,,	35*c.* (1*s.* 5½*d.*)
Grain, for horse feed, per lb.	7*c.* (3½*d.*)
Hay ,, ,,	5*c.* (2½*d.*)

Ordinary labourers receive $5 (1*l.*) per day; mechanics, $5 to $7 (20–28*s.*); Chinamen and Indians, $3 (12*s.*). These prices, though a great reduction on those ruling before the construction of the waggon-road, preclude the working of any but the richest deposits, which necessarily bear but a small proportion to those with a moderate or small amount of gold; and in working over the deep ground in early days, much was left that would even now pay handsomely, but cannot be found or reached on account of the treacherous nature of the moved ground, filled with old timbering and water. Dawson does not think it would be an extravagant statement to say that the quantity of gold still remaining in the part of Williams' Creek which has been worked over, is about as great as that which has already been obtained. With regard to Lightning Creek, this statement would scarcely hold, though there must be a great quantity of gold in ground of medium richness even here. To render this gold available, and prove successfully the lower and more difficult parts of the valleys, greater and more exact engineering knowledge, better and larger machinery, and, above all, cheaper labour and supplies (dependent on greater facilities of transport) are required.

As an illustration of what might be done in this way, it may be mentioned that it is already suggested that by cutting a flume to another creek—part of which would require to be a tunnel—free drainage of the whole upper half of Williams' Creek would be obtained, thus enabling the valley from its sources to flume level, with all its old workings, and the great depth of tailings (holding more or less gold) which have accumulated, to be completely stripped by extensive hydraulic works.

So far, mention has been made of Williams' and Lightning Creeks only, but there are many other localities in the Cariboo district which have yielded much gold in surface-work or shallow diggings, which it is believed by those best able to form an opinion, would prove rich in their deep ground, if properly explored. Owing, however, to the great cost of prospecting, and of suitable machinery, this has not yet been done. Antler, Cunningham, Jack of Clubs, and Willow River, are supposed to be especially promising; and attempts are now being made to bottom some of them. Bowren states, however, that the Nason Company have already spent $30,000 (6000*l.*) on their claim on the first-named stream, without having been able to test their ground.

In most gold-bearing countries, the placer mines, though often rich, have eventually led to the mining and treatment of the auriferous quartz from which the alluvial gold has been derived. In British Columbia, the alluvial deposits have thus far absorbed the mining energy of the country; but in view of the already diminished yield of the best-known placers, and the inevitable more or less complete exhaustion of deposits of this kind, within, at least, a moderate term of years, attention cannot too soon or too carefully be turned to the more permanent quartz-mining. Though much of the gold accumulated in the beds of the old streams of Cariboo may have been derived from veins too small to work individually, it seems scarcely to admit of doubt, that in a region where so large a quantity of gold has been obtained within so small an area, rich lodes will be discovered and worked. Indeed, notwithstanding the want of attention to these deposits, and the very difficult nature of the country to prospect, several are already known, which, in other parts of the world, might justify extensive mining operations. Some of these have been traced with considerable and well-maintained width for several miles. Specimens collected from several of the outcrops in October, 1876, proved, on analysis, the average content of gold and silver to be low,—probably too low to repay work at present Cariboo prices. By selecting for crushing, however, only the richer portions of the ore, it is possible that the percentage might be raised to a remunerative figure. A praiseworthy effort is now being made, under the auspices of the local Government, to test the better-known lodes on a practical scale, and it is to be hoped that this, coupled with the energetic prospecting of the many more or less important veins in the surrounding country, will be persisted in, till that eventual success which, in this district, may almost be regarded as assured, shall be achieved. The remarks made in connection with the placer mines, as to the cost of labour and provisions, apply in this connection with even greater force. Vein-mining, once initiated, will, Dawson believes, rapidly develop, giving to the district a permanent character which it does not now possess, and indirectly tending to cheapen labour by affording employment in summer and winter. The gold occurs, as is usual, in association with iron pyrites, but also with considerable quantities of galena, through crystalline masses of which the precious metal is sometimes strung.

The districts of Kootenay, Omineca, and the new Cassiar region, situated on the same belt of auriferous rocks, in the main features of their deposits resemble those of Cariboo. There are also several other localities on the line of the main development of the auriferous rocks, which have from time to time attracted attention, and yielded more or less gold; but from their inaccessible position, limited character, poor pay, or depth of cover, they have been abandoned or allowed to fall into the hands of Chinamen. The greater part of the Gold Range, especially towards the north, is very densely timbered, and covered with moss, peaty swamp, and tangled vegetation, rendering its examination very difficult, and the discovery of the rich spots a matter requiring time and labour; in this respect, it differs altogether from the bare slopes of California. It is to be remarked, however, that the recognised areas of all the gold-fields will be very much extended when altered conditions render deposits of the lower grades remunerative, and that many of those now fallen out of notice will again spring into importance.

The yield from Kootenay, for 1875, is stated by the Minister of Mines to have been about $41,000 (8200*l.*), 40 white and 50 Chinese miners being employed; the yield for 1876, according to the same authority, was only about $25,000 (5000*l.*). Much labour and money are being expended to bring in water at a sufficient height to work the hills and benches of Wild Horse Creek.

The Omineca district has certainly not proved so rich as it was at one time supposed to be, and has in great part been abandoned for the new field of Cassiar. In 1875, the total population was 68, the estimated gold product $32,000 (6400*l.*). The number of miners in 1876 was still smaller. The transport of supplies from Yale costs 18 c. (9*d.*) a lb., causing provisions of all sorts to be so dear that a miner cannot afford to stay unless he has a rich claim. Extensive prospecting is quite out of the question as a private enterprise, and, in consequence, great areas remain yet untried. Page, late Government agent in the district, believes the Findlay Branch to be specially worthy of examination.

A sample of quartz, with some galena, obtained on a stream running into Mansion Creek, 30 miles from Dunkeld, which was transmitted by Gavin Hamilton, of Stuart's Lake, proved, on examination by Hoffmann in the laboratory of the Survey, to contain 8·971 oz. of silver to the ton, with traces of gold. Other veins reported in this district have not been examined.

The Cassiar district is the latest and most northern discovery on the auriferous belt of British Columbia, being situated about N. lat. 59°, and separated from Omineca by over 300 miles of rough country, unknown geographically, and scarcely, if at all, prospected. Gold has long been known on the lower part of the river Stickeen, by which Cassiar is approached from the coast; but it occurs there in light scaly particles, like those obtained on many of the bars of the Fraser. The rich deposits lately discovered lie on the sources of the River Dease, and about Dease Lake, the upper end of the latter being separated by only a few miles of low country from a part of the Stickeen. The Dease empties into the Mackenzie, and thus passes to the Arctic Sea. The discovery of this district is due to Thibert and a companion, who reached it from the east, in 1872, after 3 years spent in trapping and prospecting. Good states that the area of the Cassiar gold-field, as at present developed, comprises a tract of country of at least 300 square miles. The number of miners employed during the summer of 1875 was over 800, and the gold obtained is estimated at a little less than 1 million dollars (200,000*l.*). In 1876, the estimated gold yield was $556,474 (111,295*l.*), and 1500 miners and others visited the mines. The yield for 1877 is estimated by Vowell, Gold Commissioner, at $499,837 (99,967*l.*). The number of men at the mines, exclusive of Indians, is said at no time to have exceeded 1200, of whom 300 or 400 were Chinese. Dease and McDame Creeks, the two most important in the district, are about 100 miles apart; while discoveries have been pushed northward and eastward on river systems connected with the Dease to a distance estimated at 370 miles, in a region which probably lies beyond the Province of British Columbia, in the North West Territory. A promising quartz vein, containing gold, silver, and copper, has been discovered on McDame Creek.

The Cassiar mines are worked under enormous disadvantages,—situated in an almost Arctic climate, where the soil is permanently frozen at a small depth below the surface on the shady sides of the valleys; with a short season, during which the watercourses are liable to floods, disastrous to the mines; reached after a sea voyage from Victoria, by the River Stickeen, only a part of which is navigable even under the most favourable circumstances; and with supplies of all sorts at famine prices—only the highly auriferous character of some parts of the district continues to render it attractive. It is scarcely likely that any improvement in the means of communication in the more settled portions of British Columbia will materially affect Cassiar, but the existence of its rich deposits is important, as showing the continuity of the auriferous belt of the country; and if rich metalliferous veins can be proved to exist, on which more permanent mining may be carried on, Cassiar will yet rise on its own merits to be an important mining district, drawing its supplies by improved trails, or by a road, from the central portions of the province. Beef cattle are now driven overland from the Lower Fraser to Cassiar.

It will be unnecessary to refer at any length to the Fraser River gold-deposits, the first to attract notice, but rich in only a small portion of their extent. It is estimated by Good, that about $50,000 (10,000*l.*) worth of gold was produced on the Fraser during 1875, the mining being chiefly in the hands of Chinamen and Indians. For 1876, a partial return gives a yield of about $42,000 (8400*l.*). The gold occurs along the whole course of the Fraser, irrespective of the formation over which the river may pass. Heavy gold has been chiefly found from a few miles below Boston Bar to Siska Flat, near Lytton, and on the Thompson, near Nicommen. It is no doubt derived from the rocks of the neighbourhood. The richest deposits are supposed to be worked out, though it is quite probable that many of the benches would pay for hydraulic working, if properly appointed.

In Vancouver Island, the Leech River District, situated about 20 miles from Victoria, attracted much notice at one time, and yielded a considerable quantity of gold in a small area. The total product has been estimated at $100,000 (20,000*l.*). It is interesting as having been discovered by a Government prospecting expedition fitted out for the purpose. The rocks are believed to be of the same age as those of the other gold-regions, and if this be so, it proves the persistent auriferous character of this horizon over a great area, embracing, it may be said, the whole of British Columbia. Gold in small quantities has also been found in other parts of Vancouver Island, but, owing to the impenetrable character of the forests, comparatively little is known of its interior.

Gold has seldom been found *in situ* in the southern portion of British Columbia, but occurs in remunerative quantities in placer deposits in a number of localities. These are generally found to lie on or in the immediate vicinity of certain black slaty rocks, from quartz veins traversing which the alluvial gold appears to be derived. In the search for gold placers, the extent and distribution of these slaty areas consequently becomes important, and though only a portion of the streams flowing over the slaty regions hold gold in paying quantity, a knowledge of their position may serve to deter too great expenditure of time in prospecting places probably barren, and turn attention to regions which promise better. These slaty rocks are those which have frequently been referred to by Dawson as included under the Anderson River and Boston Bar series of the preliminary classification. Rocks undistinguishable in lithological character from those of the typical region, may, it is true, occur on other geological horizons in the district under review, but no clear evidence of this has yet been obtained. The rocks are generally black, or very dark, slaty or schistose, often more or less markedly calcareous, and not infrequently micaceous or graphitiferous, more rarely chiastolitic. It is probably to the presence of a small quantity of organic matter in the sediments from which these rocks have been made, that their metalliferous character is due. Their fissile structure has subsequently rendered them easily permeable by waters, which have concentrated the minerals of economic value, with quartz and other crystalline materials of secondary origin, in the veins. The rocks, in their more typical localities, appear to lie between those of the Cache Creek groups (Carboniferous) and the upper Mesozoic rocks described as similar in age to the Shasta group of California. They seem to rest conformably on the former series, and even to blend with it, while the latter is built up on their upturned edges. They differ in appearance from the recognised Jurassic rocks of the Iltasyonco (Rep. Prog. 1876-77, p. 59), and have yielded no fossils, with the exception of obscure impressions. While a portion of these rocks may represent Jurassic beds, differing from those of the Iltasyonco region by reason of the want of volcanic materials, part at least would seem not improbably to represent the Triassic period, or even to pass downward into the Upper Palæozoic. They are not very markedly different from the slaty rocks of the continuation of the same mountainous belt in California, which are highly auriferous, and supposed to be Triassic.

On the lower part of the Fraser River, embraced in the district under discussion, no important gold-yielding bars or benches can now be mentioned; though this was the first region to attract the gold-miner to British Columbia, and yielded largely in the earlier days of gold excitement. Here it would appear, as the result of inquiry, that the richest bars, and those yielding the heaviest gold, were found precisely in that reach of the river which is occupied by the slaty rocks above mentioned. The rapid character of the river has, however, led to the distribution of the finer particles of gold throughout its entire course. No deposit of any great extent, as rich as those at first worked on the Fraser, is again likely to be found, as its valley is generally quite narrow, and the upper benches, as well as the bars near the level of the stream, have been well prospected. A considerable quantity of gold is, however, still obtained from the Fraser, when the water is at a low stage, for the most part by Chinamen and Indians. It is also probable that many of the benches will eventually pay for working by the hydraulic method.

From the Thompson, near Nicommen, the first gold known to have been found in British Columbia was brought (in 1857), and this locality has continued to yield a considerable quantity of gold at the lowest stages of the water. The gold is in large particles, and is obtained by the Indians in crevices among and beneath the stones in the river. No rocks of the slaty series are known near this place, or for some distance above it, and it is not improbable that the gold may here be derived from some of the igneous rocks of the Tertiary formation. The occurrence of gold in rocks of igneous origin, in such quantities as to produce paying placer deposits, has lately been distinctly proved in several cases, in other parts of the world, and should be borne in mind (see next chapter).

On the Nicola River, gold in thin scales has been found for about 18 miles above its confluence with the Thompson. This district is also based entirely on volcanic rocks, and the remarks made in connection with Nicommen may apply to it likewise. It is possible, however, that fine gold may in some instances have been carried far by the agency of ice and currents, to which the distribution of material in the later portion of the glacial period is due.

Tranquille River flows into Kamloops Lake, was worked before 1862, and has afforded occupation to a varying number of miners every year since. Of late it has fallen almost entirely into the hands of Chinamen, of whom an average number of 20 to 30 are usually at work. The placers on this stream at one time yielded largely, and the Chinamen are supposed to make over $50 (10*l.*) a month on it still, though it is impossible to ascertain this with any certainty. The gravels worked are those forming the banks or bed of the stream, or flats immediately adjacent to it. The flats are in a few places pretty extensive, but shallow. The bed-rock is of the Tertiary volcanic series; but it is probable that the gold has originally come from older rocks, which may be exposed further up the stream, as it is in larger particles in the upper reaches. It has been found for a distance of 8 miles in all from the mouth. Most of the gold is scaly, and mixed with it are particles of platinum, similar in shape and size to those of gold. Besides the gravels near the level of the present stream, an older series is exposed in banks about 100 ft. high on its east side, and interstratified towards the summit with the white silt deposit. The gravels are bedded, and the stones are well rounded, reaching in some cases a diameter of 6 or 8 in. The deposit is evidently a remnant of a rough delta formed by the Tranquille when the water of the lake was at a higher level, in times immediately succeeding the glacial period. It should contain gold, but Dawson could not learn that it had been found to do so in paying quantities.

At Louis Creek, on the lower part of the North Thompson, gold in remunerative amount has been discovered, and was at one time worked. Some gold has also been obtained in a small stream near the saw-mill on the west bank.

The rocks of the North Thompson hold blackish schistose or slaty layers, though probably older than those of Boston Bar. The slaty rocks of Boston Bar continue southward on the Coquihalla. Notwithstanding the similarity of the formation, however, little gold has been found on this river. Good prospects have been obtained on Ladner's Creek, and on Pierre River, which is the next tributary below it. There is little gravel in these valleys, and the streams are rapid and full of boulders.

About 3½ miles above Vermilion Forks, on the South Similkameen, gold-mining has been carried on for several years, though never employing a large number of men. A few Chinamen were working here at the time of Dawson's visit in 1877. The gold is obtained in the gravel of the lowest terrace flat, which never rises more than about 20 ft. above the river. This rests on the worn surface of the Tertiary clays and shales which form the bed-rock, and have been reached in many places, but only when the river is at its lowest stage, thus restricting the season of profitable mining. The gold is generally found in coarse scales, and is mixed with a considerable proportion of platinum in similar sized particles. The gravels hold many coarse pebbles, large stones, and even boulders. These are chiefly of greenish rocks, like those of Whipsaw Creek, but also include Tertiary igneous rocks, and granite.

The source of the stones of the gravel should be that of the gold, and the evidence favours the belief that it is derived from the green series above referred to, or from the slaty rocks associated with these. It is remarkable, however, in this case that no paying deposits of gold have been found on Whipsaw Creek itself.

The Tulameen or North Fork of the Similkameen, though yielding abundant "prospects," has never afforded remunerative employment to a large number of miners.

Further down the Similkameen, gold has been found in a few places, notably in the vicinity of the Twenty-mile Creek, where it was worked for some years.

In the cañon near the 49th parallel, a considerable quantity of gold was got in 1858-59-60. This region, soon abandoned by the whites, was worked for years by Chinamen. Rock Creek continues to afford profitable employment to a few men. About a mile from its mouth, it paid well, in some instances yielding as much as $100 (20*l.*) a day, but generally 1 to 2 oz. Some of the benches also paid, in one case yielding ½ oz. a day to the hand during the season's work. The best paying ground was where the creek crossed a belt of soft slate rock. In following it up, the cover was found very soft and deep.

Gold in small quantities has been found in several streams flowing into the Okanagan Valley, but the only one of these which has proved of importance is Mission Creek. The locality worked is situated about 7 miles from the mouth of the stream, where it is found issuing from a narrow rocky gorge into a wider valley. Some years ago, mining was carried on in the bed of the creek, and very good pay was got for a time in a reach of about ½ mile below the gorge above mentioned; 2 or 3 oz. of gold were obtained per diem to the hand in some instances. No remunerative ground was found above the gorge or cañon. The mining now in progress is on the lowest bench or river-flat, the "pay-dirt" in the McDougall's claim (which was the best at the time of Dawson's visit in 1877) being a cement or gravel, consolidated by calcareous matter, which is probably local in origin. This rests upon a bed-rock which the miners call a rotten slate, but it is really a dark-coloured bed of the Tertiary formation, that here overlaps the older rocks. The gravel of the flat rests on the Tertiary beds, which, a little farther from the cañon, become yellowish and paler in tint, but are all fine-grained clays or shales. Nodules of iron-stone derived from the Tertiary are abundant in the gravels, but not observed in place. The pay-dirt in the McDougall's claim is about 3 ft. thick, and has to be stripped of 8 ft. of useless gravel. It was wheeled in barrows to the river (about 20 yd.), and washed in two lengths of boxes, though, as all the gold is coarse, it is stopped for the most part at the first riffle.

The rocks seen in the cañon are gneissic, of the character of those so extensively developed east of the south end of Okanagan Lake. About ¼ mile from the lower end of the cañon, they are very regularly arranged, but lower down are cut by faults and traversed by quartz veins. At the lower end of the cañon, the Tertiary deposits overlap these rocks, as above noted. Gold has been found in gravels resting on the surface of the old rocks, but in irregular pockets formed by the uneven hollows into which they are worn. It is not until these gravels are found spreading more widely and in thicker masses over the Tertiary beds, that the richer gold deposits occur. The rocks underlying the Tertiary are superficially decomposed and shattered, and pass upward into a clayey breccia, which is soon followed by clays and shales. Were the lower bed of Tertiary a water-formed conglomerate, instead of having the character above described, it would probably form a rich gold-bearing horizon. Such water-worn materials, marking the courses of streams of pre-Tertiary age, must occur in many places throughout the gold-bearing districts; and, though now difficult to find, may probably if discovered yield rich returns.

The best deposits of Mission Creek have doubtless been already worked; but it is not impossible that some of them would pay for working again at present prices, or that some of the higher benches might yield profitable returns by the hydraulic method.

Cherry Creek, a tributary of the Shuswap River, has afforded a considerable quantity of gold, and still gives employment to a few white miners and a number of Chinamen. The portion of the Creek which has proved remunerative is that part of the South Fork extending for about 3½ miles above its junction with the North Fork. The actual valley of the stream is here a narrow depression about 225 ft. in depth, which scores the bottom of a broadly rounded valley, beyond which the mountains rise. This valley must have existed and carried a stream similar to the present in pre-glacial times, and it appears highly probable that the pre-glacial stream occupied, at least in part, the actual river course now pursued by its successor. When the glacier-ice, which doubtless extended thus far from the axis of the Gold Range, retreated, leaving the valley blocked with moraine material and boulder clay due to its action, at this time, or in that immediately following it, the stream again began taking its way down the valley, and excavating its bed. The soft materials were rapidly removed, the stream at first changing its bed frequently, but at last subsiding into the deep narrow valley in which it now flows. In some places this would appear to be identical with the original valley, while in others it is probable that a new course has been cut out in the rocky floor of the wide valley, leaving the old channel yet buried with drift on one side of the present. The cañons with steep rocky sides may represent such places in which the stream has abandoned the pre-glacial channel, and cut for itself a more direct course.

Such is a theoretical account of the Cherry Creek Valley, which Dawson believes to be borne out by the facts; and if so, it becomes available as a valuable clue in tracing out the gold-deposits. Gold was originally worked in the bed of the stream by "wing damming," and this mode is still followed; but at the time of Dawson's visit in 1877, the best paying claim was situated on a little bench about 30 ft. above the stream. The outer edge of this bench, and the slope between it and the creek, is composed of rock, in following the surface of which under the bank, it is found to be covered with 5 to 8 ft. of rough bouldery gravel, which constitutes the pay-dirt. The rocky surface is also found to be smoothly water-worn, and to slope away beneath the bank; and it is soon buried under a great thickness of the stony clays. It would appear that the course of the pre-glacial stream was here to one side of the present, an idea confirmed by the fact that the bed-rock is found to slope away under the bank, in the same manner as in two other places at an extreme distance of about 300 yd. It is by no means improbable that this channel may leave the present, and, running round to the left of the little hill at the cañon which separates the upper from the lower workings, may again join the present valley. If such a fact can be proved, for this or any other similarly circumstanced part of the stream, a considerable area of "deep diggings" would at once be defined. The claim above mentioned was yielding about $10 (*2l.*) a hand for each working day. The bank overlying the pay-dirt was being removed by the hydraulic method.

During the autumn of 1877, a nugget worth $130 (26*l.*), besides two others worth $90 (18*l.*) and $40 (8*l.*) respectively were obtained in this claim.

The prevalent rocks in this part of Cherry Creek are blackish slates and shales, which are traversed by many quartz veins. The gold obtained here is worth $15 60c. to $16 (3*l.* 2*s.* 6*d.* to 3*l.* 5*s.*) an oz., containing a considerable percentage of silver.

Scotch Creek, flowing into Shuswap Lake from the north, has yielded some heavy gold, but no mining is now going on there. About 15 miles from Clinton, near the stream which flows from Kelley's Lake, F. W. Foster has discovered a quartz vein, a sample of which has yielded on analysis, in San Francisco, gold 1·21 oz., silver 2·43 oz. to the ton, with ⅖ per cent. of copper. Specimens of pyritous quartz from the veins of the vicinity of Cinnemousim Narrows hold little of value.

It has been supposed that the gneisses, mica-schists, and similar rocks of the Gold Ranges bounding the Interior Plateau north-eastward, have an origin similar to a part at least of the Coast Ranges. But they have a somewhat different aspect from these, with an appearance of greater antiquity; and it is by no means improbable that the Cache Creek rocks may be found to rest unconformably upon them, though this has not yet (1877–8) been demonstrated. If so, they may form a portion of the oldest land of this part of the Cordillera system, representing the "Archæan" described by the U.S. geologists in Colorado and Utah. The rocks, as shown on the Shuswap Lakes, present, indeed, a striking resemblance to the Upper Archæan group, as defined by Clarence King. The precise relations of these, and of the gold-bearing rocks of Cariboo and elsewhere to them, constitute one of the more interesting and important problems to be worked out in this field.

In the Queen Charlotte Islands, no alluvial gold seems to have been found, but auriferous quartz exists in some quantities. As far back as 1849–50, the Haidas or Skidegate Indians brought rough gold to Fort Simpson, on the mainland opposite; their mode of obtaining it was to light fires over the vein, and dash cold water on the heated rock, which was thus disintegrated, and made to expose the metal. The Hudson's Bay Company sent a party in 1852 to explore the diggings at Una Point or Mitchell Harbour, an anchorage of Gold Harbour or Port Kuper, where a vein was found 7 in. wide, and traced for 80 ft., yielding 25 per cent. of gold in many places. The heaviest pieces extracted weighed 14 to 16 oz. The Indians gave very great trouble, but a considerable quantity was secured, and the "pocket" was apparently worked out, as the vein has not been traceable since, despite many searches.

The following is a summarized list of the localities in British Columbia known to yield gold, with notes of their present condition, so far as can be gathered up to date:—

Cariboo District.

Williams' Creek.—Its tributaries, in order down stream, are :—

McCallum's Gulch.—Joins from E. ; nearly worked out ; no deep ground.

Mink Gulch.—Joins from W. ; prospects not considered very encouraging by owners, who are waiting for the bed-rock flume, with intention of hydraulic work.

Walker's Gulch.—Joins from W. at Richfield Court House ; deep work ; good prospects at different times, and some quantity of gold taken out about its mouth, but has not held out. Not yet thoroughly prospected.

Grub, or Black Jack Gulch.—Joins from W., a mere ravine of no great length, being all embraced in one claim ; good pay for hydraulic method, and still worked.

Stout's Gulch.—Joins from W., below the cañon ; very rich, but worked out for drifting ; hydraulic method now employed ; ground enough for many years.

Conklin Gulch.—Joins from E., opposite Barkerville ; very rich ; still worked by drifting ; ground very deep for so small a valley, being 90 ft. in lower part, and 20 in highest ; drifting claim 1½ miles up, probably rich for hydraulic working.

McArthur's Creek.—Two miles below Barkerville, and one mile above Lane and Kurtz shaft-house ; joins from S.W. ; paid well in drifting deep ground, but now worked out for this method ; no hydraulic work in progress.

Lowtree Creek.—Runs N., nearly parallel to Williams' Creek, and empties into Jack of Clubs Lake, which also receives Jack of Clubs Creek, and is the source of the Willow River ; good pay found in both shallow and deep diggings, and some good ground still being worked ; gold, especially near source of creek, very coarse and rough, often including fragments of quartz ; found difficult to obtain water for hydraulic work here.

Jack of Clubs Creek.—All deep work on this creek, gravel being 150 ft. in depth near the mouth, where a few claims paid well ; this creek is a favourite among those which are considered yet unproved, the impression being that an old channel exists which has not yet been found.

Creeks entering Willow River :—

Mosquito Creek and Red Gulch.—Enter from S. ; the former has been very rich, and was 50 ft. deep at mouth ; now worked out for drifting ; hydraulic work paying well.

Whipsaw Creek.—Three miles below Mosquito Creek, on the same side ; in former years, $10 to $12 (40*s.* to 50*s.*) per day per hand taken out, and more or less work carried on ever since by ground-sluicing and drifting.

Several creeks below Whipsaw Creek, on the S.W. side of Willow River, have afforded no pay; fair prospects have been obtained in several creeks on N.E. side, but no paying ground found.

Sugar Creek.—Twelve miles below Mosquito Creek, joining from N. Some good prospects, but never much pay.

Creeks lower down Willow River are known to hold some gold, but have not yielded it in paying quantity.

Grouse Creek.—Six miles E. of Barkerville, heading with Antler Creek. The deep ground was very rich, and extended for about a mile near the upper part of the creek, giving out farther down. Deep ground worked out.

Antler Creek.—Heads in Bald Mountain, opposite Williams' Creek, and was one of the first creeks worked in this part of the country. Shallow ground for 2 miles, paid well, and has been worked out. The deep ground has not yet been much tested, owing to the absence of clay, and consequent large quantity of water met with in sinking. All the gulches joining Antler Creek, from the source down, have paid (Wolf, California, Stevens', and Begg's Gulches). The creek has never been bottomed where these side-valleys fall in. Chinamen are at work, and getting pay, on benches 100 ft. above the stream, a long way down.

Pleasant Valley.—A transverse depression, 4 miles in length, uniting the valleys of Williams' and Antler Creeks, and joining the former about 4 miles below Barkerville. Has never been bottomed or much prospected, but might be embraced in a scheme for draining Williams' Creek.

Bear Creek, and country about Bear Lake.—Gold has not been found here in paying quantity.

Swamp River.—Has attracted attention, but no good pay found.

Cunningham Creek.—In early days, a crevice containing 600 oz. of gold was found on this creek, about 12 miles from its mouth. Several hydraulic claims working. Since 1864 attempts to reach the deep ground have been made, but have not yet succeeded; a third effort is now being made by the Victoria Company. It has always been supposed that the deep ground in this creek would turn out rich, and if once proved to be so, a large amount of work would immediately be undertaken.

Harvey's Creek.—The first gold in paying quantity in the Cariboo District was found here in 1860. One claim—the Minnehaha—has been exceedingly rich. Another, at the junction with Swamp River, has paid well. The Cummings Company bottomed it at one place, and drifted up in a small cañon (unsuccessfully), but found pay on entering wide ground. The upper part is deep, and has not yet been thoroughly proved.

Creeks on the North side of Cariboo Lake.—In Nigger, Pine, and

Goose Creeks, small quantities of gold have been found; on the last-named, much money was spent in putting in a flume, with small result.

Keithly Creek.—The main creek has only moderately deep ground, (20 to 23 ft.), much of which is yet unworked, it being expensive to open on account of the great quantity of water. About 30 white men did well here during the summer of 1876; while a number of Chinamen, at work about the mouth, also got good pay. Benches 100 ft. above the stream have paid for open work, and some of them for drifting also. Hydraulic method not yet in use here.

Snow-shoe Creek.—The E. branch is considered to be one of the most promising creeks of which the deep ground is yet unprospected; gold obtained from shallow workings; estimated yields, $9000 (1800*l.*) in 1878, $25,000 (5000*l.*) in 1879, $44,000 (8800*l.*) in 1880.

Duck Creek.—Chinamen have been working here, but not much known as to results.

Black Bear Creek.—Much prospecting has been done here, but rich pay never found; not yet considered fairly tested, the ground being hard.

Cedar Creek.—One pretty rich claim was worked here, the Aurora. The creek is now tenanted by Chinamen.

Hazeltine's Creek.—Some encouraging "prospects" obtained.

Moorhead Creek.—Some work done here, but without good result.

Kangaroo Creek.—Joins North Fork of Quesnelle, about 2 miles above its junction with the South Fork. Paid well at one time. Chinamen now at work.

Quesnelle River.—Most of the work done on bars of river, though many workings, on benches 100 to 150 ft. above the water, pay well. The gold is all light. This region is altogether in the hands of Chinamen, who resort chiefly to the Forks and south branch. About 300 Chinamen work in this district during the summer, and winter at the Forks. Comparatively rich ground was discovered on the upper benches in 1880.

Swift River.—Rather inaccessible, and hard to work, being a rapid stream with many heavy boulders. Considerable quantities of gold have been taken from it, from time to time, and Chinamen still at work, though the stream, as a whole, may be considered unprospected.

French Creek and Canadian Creek.—Joining Pleasant Valley from the south; have both yielded some gold, which, though run through where the working was carried on, is probably not exhausted.

Cañon Creek.—A stream running into Willow River far down its course, and reached by a trail 20 miles long from Beaver Pass House. A company engaged in attempting to bottom it, with good prospects.

Cañon Creek.—A second stream of the same name, joins the Fraser from the east above Quesnelle. A considerable quantity of gold obtained here formerly, some of it very heavy, and mixed with quartz; one nugget worth $700 (140*l.*) found by Chinamen on its branch—Hickson Creek. An auriferous quartz vein is known.

Lightning Creek.—Its chief tributaries are as follows:—

Amador Creek.—No good pay yet found.

Van Winkle Creek.—About 2000 ft. of the lower end paid well.

Chisholm Creek.—Good pay in shallow workings. Deep ground unproved, though great efforts have been made to test it.

Last Chance Creek.—Estimated that $250,000 (50,000*l.*) worth of gold taken out of this creek in the distance of half-a-mile. Rich ground now probably worked out.

Davis Creek.—Good pay in shallow ground.

Anderson Creek.—Good pay in shallow ground.

Jawbone Creek.—No good pay found.

Quartz Veins in the Cariboo District.—Many are known, some very persistent and of large size. So little has yet been done towards the examination of these, that it is scarcely worth while attempting to enumerate them. That known as the Big Bonaza, between Lowtree Creek and Stout's Gulch; the Stedman, at Richfield; and an irregular mass of quartz, at Mosquito Creek, have so far attracted most notice.

Cassiar District.

Stickeen River.—54° to 56° N. lat., discovered in 1867. Highest average yield per day, $4 to $5 (16*s.* to 20*s.*); bar and bench diggings. A few claims being worked, but nearly exhausted.

Dease Creek.—Lat. 58° 42′ 50″ N.; altitude 2750 ft. Discovered in 1873. Highest average yield per day, $8 to $50 (1*l.* 12*s.* to 10*l.*); gold worth $16 (3*l.* 6*s.* 8*d.*) an oz. The richest claims are worked out, but mining will be carried on for a good many years to come. Dease Creek has probably yielded about $700,000 (140,000*l.*) in 3 seasons. Estimated yield in 1877 season, about $125,888 (25,178*l.*); in 1880, $133,850 (26,770*l.*).

Thibert's Creek.—Lat. 58° 50′ N.; altitude 2750 ft. Highest average per day, $8 to $50 (1*l.* 12*s.* to 10*l.*); gold worth $16 40c. (3*l.* 8*s.* 4*d.*) an oz. Bar, bench, and creek diggings. A portion of the creek worked out, but still paying well. Bench diggings recently discovered very rich. Yield up to 1877 season estimated at $300,000 (60,000*l.*).

Beady Creek.—Lat. about 58° 53′ N. Discovered, 1874. Bar diggings. Prospects found, but no extensive mining ever done.

Eagle River.—Lat. 59° 6′ 14″ N. Discovered, 1874. Bar diggings, undeveloped.

McDame's Creek.—Lat. 59° 15′ 54″ N.; altitude of mouth 2550 ft. Discovered, 1874. Highest average yield per day, $6 to $100 (24*s.* to 20*l.*); gold worth $17 75c. (74*s.*) an oz. Bar, bench, and creek diggings.

This is the most important creek in the Cassiar region, the yield continuing about the same each year. It is being worked in places for a distance of 15 miles, and will yield largely for several years. Estimated yield for 2 seasons, $425,000 (85,000*l.*); for 1877 season, probably $250,000 (50,000*l.*) This includes the yield for several of the small creeks and tributaries of McDame: Somers Creek, Snow Creek, Quartz Creek, Rosella Creek, Davies' Creek, and Gold Creek.

Snow Creek.—Altitude, 3400 ft. Discovered, 1875. Highest average per day, $5 to $20 (1*l.* to 4*l.*); gold worth $18 (75*s.*) an oz. Bench diggings, still mined extensively; the richest claim in Cassiar, near the mouth of this creek, has paid for a week as high as 300 oz. for 6 or 8 men; 72 oz. washed out of one pan of dirt during 1876 season.

Quartz Creek.—Altitude, 3550 ft. Discovered, 1875. Highest average per day, $5 to $20 (1*l.* to 4*l.*); gold worth $18 (75*s.*) an oz. Bench and creek diggings; best claims worked out.

Rosella Creek.—Altitude, 3550 ft. Discovered, 1876. Highest average per day, $5 to $15 (1*l.* to 3*l.*); gold worth $18 25c. (76*s.*) an oz. Bench and creek diggings; best claims worked out.

Dennis Creek.—Altitude, 3500 ft. Discovered, 1877. Highest average per day, $5 to $20 (1*l.* to 4*l.*); gold worth $18 25c. (76*s.*) an oz. Bench and creek diggings. Many miners here.

Patterson Creek.—Altitude, 4380 ft. Discovered, 1877. Highest average per day, $5 to $20 (1*l.* to 4*l.*), the gold being worth $18 (75*s.*) an oz. A few companies at work.

Gold Creek.—Altitude, 4300 ft. Discovered, 1877. Highest average per day, $5 to $50 (1*l.* to 10*l.*); gold worth $18 (75*s.*) an oz. Bench and creek diggings, a few companies at work.

Slate Creek.—Altitude, 4320 ft. Discovered, 1877. Highest average per day, $10 (2*l.*); gold worth $18 (75*s.*) an oz. Bar diggings, one company at work.

Somer's Creek, or First North Fork of McDame.—Altitude, 3000 ft. Discovered, 1876. Highest average per day, $10 to $100 (2*l.* to 20*l.*); gold worth $18 (75*s.*) an oz. A large number of tunnels being worked, with good prospects.

Third North Fork of McDame.—Altitude, 3200 ft. Discovered, 1877. Creek and hill diggings; good prospects obtained, and several companies testing.

Sayyeas Creek.—Lat. about 62° N. Discovered, 1875. Highest average per day, $8 to $10 (32*s.* to 2*l.*); gold worth $18 25c. (76*s.*); abandoned, 1876.

Spring Creek.—Altitude, 3800 ft. Discovered, 1877. Highest average yield, $10 to $20 (2*l.* to 4*l.*); gold worth $18 25c. (76*s.*) Hill diggings; only one company working, but a very rich bench; no prospecting yet in creek.

De Liard River.—Lat. 60° to 62° N. Highest average per day, $6 to $8 (24*s.* to 32*s.*); gold worth $18 (75*s.*). Bar diggings, but little mining done; some tributaries being prospected.

Rapid River.—Lat. 60° N.; prospects obtained.

Omineca District.

Germansen Creek.—Good pay in part of course; some creek claims, and part of work by hydraulic method on the benches.

Mansen River.—Only two companies at work in 1875, and making less than wages.

Slate Creek.—Miners stated to be making expenses in 1875.

Elmore Gulch.—Poor pay in 1875, two companies at work.

Lost Creek.—Little work in 1875.

Details of other localities wanting.

Kootenay District.

Wild Horse Creek.—Discovered in 1863; in 1864, ordinary claims paid $20 to $30 (4*l.* to 6*l.*) a day per man; work still in progress.

Perry Creek.—Discovered, 1867. Some good claims, and some work still in progress.

Findlay Creek.—Good prospects; but, owing to freshets, never successfully mined.

Great Bend Country.

(Now almost abandoned.)

Carnes' Creek.—Joins Columbia River from E. Heavy gold, some pieces worth as much as $14; mining on bars; the bed-rock not being reached on account of water. For a time, below the cañon, the average earnings were $15 (3*l.*)

French Creek.—Empties into Downie River about 20 miles from its mouth. This was the richest in the district, and was worked both on bars and to the rock. Average earnings as much as $100 (20*l.*) to the hand for some time on the Half Breed claim. Worked out.

McCuller's Creek.—Joins Downie River 4 miles from French Creek; working on bars; the bed-rock not reached on account of water. Probably as high as $100 (20*l.*) a day per man taken out in places, but deposit irregular. Fragments of quartz containing gold were found 4 miles up the creek.

Other Districts.

Parsnip River.—Below its junction with the Nation River, draining the Omineca country. This stream carries fine gold, which has proved highly remunerative in some localities.

Findlay River.—Fine gold found on all the bars, but the head waters (where richer deposits may occur) have not been prospected.

Peace River, E. of the Rocky Mountains.—Fine gold is found in some abundance in places. Selwyn thinks it may be derived from the Laurentian axis to the N.E.

Fraser River.—Fine gold from its sources to the sea. Heavy gold does not extend far below Boston Bar, but is found in many places from here to Lytton, also in spots from Lytton to the mouth of the Chilicotin. Much gold is still obtained by Chinamen and Indians on the Fraser, and it is probable that eventually, many of even the higher flats and benches will pay for hydraulic work. Already much new ground was taken up here in 1880. The heaviest gold pretty nearly coincides in its distribution with that of the slaty rocks of the Anderson River and Boston Bar series. The largest nugget found above Lytton was obtained 10 miles below Lillooet, and was worth $22 (91*s.* 8*d.*)

McLennan's Creek.—(Thirteen miles from Tête Jaune Cache, running into Cranberry Lake and thence to the Fraser). Gold found in 1876. Giving wages of $4 to $5 (16*s.* to 20*s.*) a day, but owing to heavy boulders in stream, and expenses of all supplies, will not pay to work.

Nechacco River.—Colours obtained near Fort Fraser, and abundant near its junction with the Fraser River.

Chilacco River.—In certain banks near its mouth, 8 or 9 colours to the pan may be obtained. A small quantity of heavy gold found in a lateral creek by one of the men connected with the Canadian Pacific Railway survey in 1876.

Chilicotin River.—Gold in some quantity is said to have been found near the mouth of this stream.

Bridge River.—Gold found in heavy pieces, sometimes weighing 1 or 2 oz., and affording excellent mining on this stream for 10 miles up from its mouth. One nugget is said to have been worth $300 (60*l.*) River prospected to its source in early days, and though gold found in several streams, not enough to justify work at that date.

Lillooet River.—Flowing into Harrison Lake. Some gold found here, and at various points on the portages towards Lillooet.

South Thompson River.—Colours, it is said, can be obtained in all the streams joining this river.

North Thompson River.—Colours found along its whole course, and at Louis Creek, 30 miles from its mouth, on the E. side, gold has been found in paying quantities.

Tranquille River.—Joining Kamloops Lake from the N. Heavy and light gold obtained here; about 60 Chinamen at work in 1876 summer, getting good pay; it is said to have given ½ oz. per diem at the mouth.

Scotch Creek.—Joining Shuswap Lake from the N. Coarse gold mined here a few years ago.

Main River Thompson.—Heavy gold found on this river up to Nicommen, where, it is believed, the first gold in paying quantity in British Columbia was found. This region chiefly worked by the Indians of the country, who have obtained many thousand dollars in specially favourable years.

Anderson River.—Some heavy gold at one time found 10 miles above mouth, but not enough to pay.

Coquihalla River.—More or less heavy gold along whole course.

Nicola River.—"Scale gold" for about 18 miles up from mouth.

Buonaparte River.—A little mining done on a tributary east of Clinton, but without encouraging result.

Hat Creek.—Small quantities of gold have been found here.

Horse-fly River.—Good "prospects" here, and in 1876 a considerable influx of miners, but without good returns.

Skagit River.—Colour found in several places in 1858, but no favourable indications.

Similkameen River.—Gold found in sharp and unwashed particles at mouth in 1853 by Captain McLennan's party. In the cañon near the 49th parallel, considerable quantity of gold got in 1858–59–60, the largest piece weighing $22 50c. (4*l.* 13*s.* 9*d.*). This region, soon abandoned by the whites, was worked for years by Chinamen.

Okanagan River.—Scattered diggings formed in 1859–60, but soon abandoned, perhaps as much from want of water as anything else. Miners say colours are found in every stream running into this valley.

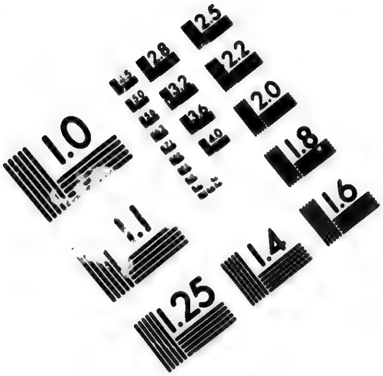
Mission Creek.—Joining Okanagan Lake from E., yielded at a spot 3½ miles from its mouth, fine and coarse gold, assaying $18 50c. (77*s.*); paid at one time from 2 or 3 oz. to $2 or $3 a day. Colours occur for 8 or 10 miles above this.

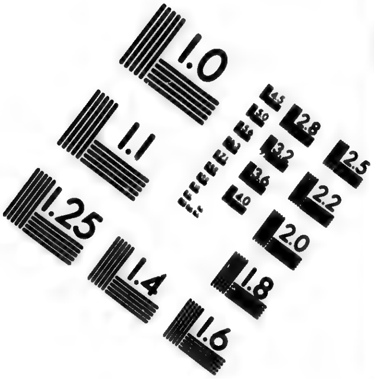
Rock Creek.—Rising east of Osoyoos Lake, and falling into the Kettle River; about a mile from its mouth, paid well, in some instances yielding as much as $100 (20*l.*) a day, but generally 1 to 2 oz. Some of the benches also paid, in one case yielding ½ oz. a day to the hand during the season's work. The best paying ground was where the creek crossed a belt of soft slate rock; in following it up, the cover was soft and deep.

Boundary Creek.—Joins Kettle River from E. Some very heavy gold found here, and a good deal of prospecting done, but too much "spotted" to be profitable.

Kettle or Nehoialpitkwa River.—Colours and small quantities of gold found in several localities on the main stream and on tributaries.

Seymour Creek, Burrard Inlet.—Some gold got here at one time, but work abandoned on account of water and quicksand.





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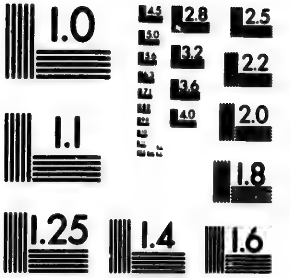

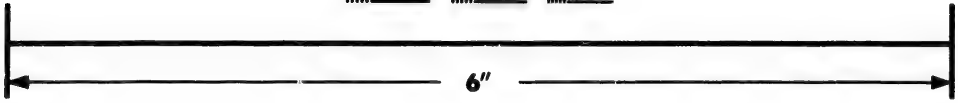

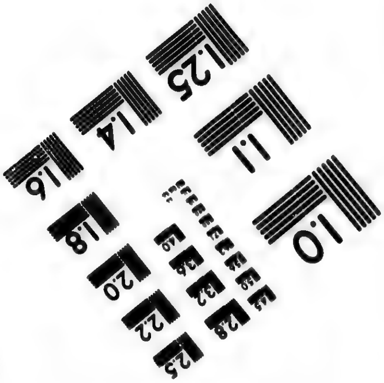

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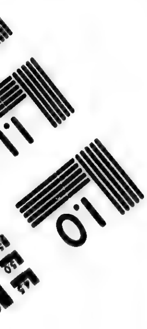
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Prospect Creek.—E. branch Homathco River, above Tatlayoco Lake. Some fine gold found here in 1875.

Lower Homathco River.—Colours obtained in various places.

Other Streams flowing from Cascade Range.—Details are wanting for most, but it is probable that colours, at least, can be found in all.

Kelly's Lake Creek.—Specimens of quartz found near Clinton, assayed $25 12c. (5*l.* 4*s.* 8*d.*) in gold, and $3 14c. (13*s.*) in silver, per ton.

Vancouver Island.

Leech River.—This stream has proved auriferous for 4 miles of its length, where it runs along the strike of a belt of slates. Estimated that $100,000 (20,000*l.*) taken out, but no work now going on. The rich ground was found in the modern river bed, and is supposed to be exhausted, or, what may remain, too much spotted to pay. Banks of drift and cement might possibly pay for working by hydraulic method.

Sooke River.—Below its junction with Leech River. Only fine gold found here, and probably derived from Leech River slates.

Goldstream Brook.—Runs on strike of Leech River slates, farther E.; colours, but no pay, found here.

Jordan River.—Small quantities of gold have been found here.

Nanaimo River.—Attracted some notice in 1877, but does not appear to have paid prospectors.

Other localities on Vancouver Island.—Good colours found by the Vancouver Island exploring expeditions on a stream entering Cowichen Lake, on rivers falling into Barclay Sound, on the south side, and on streams tributary to Puntledge Lake, near Comox.

Queen Charlotte Islands.—Gold-bearing quartz found at Mitchell's Harbour, lat. 52° 25′ N. Some work done in 1853, but lode appears to have run out.

The annexed table (pp. 66–7) shows the condition of the auriferous industry of British Columbia in 1880. It will be noted that no quartz mining is being carried on.

Canada.—The gold-bearing region of Lower Canada was made the subject of an elaborate report, from personal exploration, by A. Michel, in 1866. It may be summarized under two heads, alluvions and veins.

Alluvions.—The auriferous alluvions of Lower Canada cover an extended region; in 1852, the Geological Commission had already shown their occurrence over more than 10,000 square miles. The gravels, through which the gold is very irregularly distributed, are generally covered by a layer of vegetable earth, and often by a bed of clay. They repose in part upon metamorphic Lower Silurian rocks, consisting of schists, generally talcose, micaceous, or chloritic, associated with diorites and serpentines. But to the southward, these Lower Silurian strata are unconformably overlaid by others of Upper Silurian age, which are also covered by gold-bearing alluvions. These upper rocks consist of argillaceous schists, with sandstones and limestones, all more or less altered. The rocks of these two formations, but especially of the Upper Silurian, are traversed by numerous veins of quartz, running in the direction of the stratification, or between N.E. and E.

Many of the gold-seekers in the Chaudière Valley imagine an analogy between the auriferous alluvions of Lower Canada and those of California and Australia; Michel would compare them with those of Siberia, where, in the Ural and Altai Mountains, the auriferous sands are rarely found reposing on granitic or syenitic rocks, as in South America, but almost always on schistose rocks in the vicinity of diorites and serpentines, which has led Russian mining engineers to consider the gold as having "its principal source in the ferruginous quartz of the metamorphic schists, and in the vicinity of the serpentines and diorites."

Alluvial gold has been profitably sought for in the Chaudière River itself, at its junction with several rapid tributary streams. But it is at the Devil's Rapids, where the Chaudière makes a sharp turn and runs west-south-west, that gold has been most abundantly found in the cavities, fissures and cracks of the clay-slates, which often form the bed, both of this river and its tributaries, and are here seen running in the direction just mentioned, forming parallel ridges which are uncovered in low water; at which times the country people are enabled to break up and search these slaty rocks to the depth of several feet. The fissures of these rocks are filled with a clayey gravel in which the gold is met with, and metal to the value of several dollars has been extracted from between the layers of the slate. In one of these bands of slate, which the country people call veins, the gold is tarnished by a black earthy coating of oxide of manganese. This deposit of alluvial gold occupies a distance of about a mile of the river's bed, and is situated below the gold-bearing quartz vein (described in Report for 1853–6, p. 370), and which is known in the locality as the O'Farrell vein; it has now been broken away down to the level of the slates. Alluvial gold is found in greater abundance and in larger pieces in its vicinity.

At the Devil's Rapids, an excavation on the right bank, and about 20 ft. distant from and below the Kennebec road, was opened, having the slate rock for its floor, and continued for about 200 ft. in a hard alluvial conglomerate cemented by clay. The whole amount of gold obtained in this working was only about $150. Gold has also been found in many places in the bed of the Chaudière at low water, and no doubt companies willing to incur the necessary expenses might work with profit certain portions of this river between the rapids just named and its junction with the Du Loup.

Name of Bar, Gulch, Creek, or River.	Companies working.	Companies getting gold.	Companies prospecting.	Average number of men employed during season.		Rate of Wages.	
				Whites.	Chinese.	Whites.	Chinese.
CARIBOO.						$ c.	$ c.
Barkerville Division:							
Williams' Creek	25	20	5	70	29	4 00	250
Conklin's Gulch	3	3	..	16	..	„	„
Grouse Creek	4	3	1	13	8	„	„
Antler „	15	13	2	27	8	„	„
Cunningham Creek	4	4	..	..	20	„	„
Lowtree „	4	4	..	9	16	„	„
Mosquito „	5	5	..	11	3	„	„
Canadian „	1	1	..	2	..	„	„
Hardscrabble „	1	1	..	4	..	„	„
Jack of Clubs „	4	2	2	30	3	„	„
Stout's Gulch	3	3	..	9	6	„	„
Sundry other Claims	..	..	..	..	..	..	..
Lightning Creek Division:							
Coulter's Creek	1	1	..	..	3	..	2 50
Peter's „	2	1	1	6	7	4 00	3 00
New „	2	..	2	4	3	„	„
Barry „	1	1	..	..	6	..	„
Burn's „	4	3	1	3	15	„	2 50
Chisholm „	3	2	1	9	..	„	..
Fountain „	2	2	..	..	14	..	3 00
Anderson „	1	..	1	3	..	..	..
Perkin's Gulch	3	2	1	7	..	..	..
Davis Creek	2	2	..	..	12	..	2 50
Swift River	2	2	..	..	10	..	3 00
Slough Creek	1	1	..	..	3	..	„
Montgomery Creek	1	1	..	..	4	..	„
Nelson Creek	5	5	..	..	20	..	„
Cottonwood River	6	6	..	..	22	..	2 50
Last Chance Creek	3	3	..	3	6	4 00	„
Basford „	1	..	1	2	..	„	..
Dead Wood „	2	2	..	2	6	„	3 00
Ruchon „	3	2	1	4	2	„	„
Lightning „	12	7	5	29	16	„	„
Keithley Creek Division:							
Snowshoe Creek	14	12	2	30	40	„	2 50
Keithley „	10	8	2	14	44	„	„
North Fork, Quesnelle River	5	5	..	..	38	..	..
South „ „	5	5	..	..	30	..	..
Quesnelle River, upper	..	..	..	..	40	..	..
Various Gulches and Bars	..	..	..	..	..	..	..
Quesnellemouth Division:							
Quesnelle River, lower	..	..	..	..	120	..	2 50
Fraser River, Quesnelle to Soda Creek	1	1	..	..	21	..	„
Fraser River, above Quesnelle	..	..	..	9	75	3 50	„
Hickon Creek and Tributaries	..	..	..	..	50	..	..
Desultory mining	..	..	..	..	..	..	..
CASSIAR.							
Laketon Division:							
Dease Creek	35	35	..	44	113	5 00	3 00
Thibert „	29	29	..	68	72	„	„
Defot „	12	12	..	35	5	6 00	4 00
McDame Creek Division:							
McDame and adjacent Creeks	61	..	..	145	100	6 00	4 00
LILLOOET.							
Fraser and Bridge Rivers	3	3	..	4	100	3 00	1 50
McGilvery Creek, Anderson Lake	1	1	..	5	..	„	..
Indian and Chinese mining (no records)	..	..	..	..	..	..	..
KOOTENAY.							
Wild Horse Creek	23	23	..	8	59	4 00	3 00
Perry „	1	1	..	..	6	..	„
Weaver „	2	2	..	4	..	4 00	..
Palmer's Bar	1	1	..	2	1	„	3 00
KAMLOOPS.							
Tranquille River	4	4	..	..	23	..	1 00
YALE AND HOPE.							
Fraser River and Tributaries, Hope to 34-mile Bar	13	..	..	48	15	..	..
OMINECA.							
Manson Creek	11	11	..	20	..	6 00	3 00
Black Jack Creek	4	4	..	12	4	„	„
Germansen „	7	7	..	8	16	„	„
Vital „	1	1	..	14	6	„	„
Various Creeks and Gulches	4	4	..	14	3	„	„
	373	271	28	747	1,213		

Nature of Claims.				How worked.					Value of Gold per ounce.	Estimated value of yield for the year.	Total.
Bar.	Creek.	Bench.	Hill.	Rocker.	Sluices.	Hy-draulic.	Shaft.	Tunnel.			
									$ c.	$	
..	10	..	15	..	2	15	5	3	16 00	79,000	
..	3	..	..	..	..	..	3	..	"	24,700	
..	3	..	1	..	3	1	..	..	15 75	9,800	
..	6	9	..	..	14	..	1	..	16 50	16,500	
..	4	..	..	..	4	..	..	..	16 00	6,200	
..	4	..	..	..	1	1	2	..	17 00	21,300	
..	5	..	..	..	3	2	..	..	17 25	10,000	
..	1	..	..	..	..	..	1	..	16 00	500	
..	1	..	..	..	..	1	..	..	17 00	2,500	
..	4	..	..	..	..	..	4	..	16 25	16,100	
..	3	..	..	..	..	1	2	..	17 00	8,400	
..	..	..	..	..	..	..	..	..	..	24,000	219,000
..	..	..	1	..	..	..	..	1	17 50	200	
..	2	..	..	.	2	..	..	..	17 00	900	
..	..	..	..	..	..	..	..	..	..	..	
..	1	..	..	..	..	1	..	..	17 00	400	
..	2	2	..	..	2	..	2	..	17 25	3,700	
..	..	..	..	..	..	..	..	..	17 00	1,800	
..	2	..	..	..	2	..	..	..	"	5,700	
..	..	..	1	..	..	..	..	1	..	..	
..	2	..	1	..	2	..	..	1	17 00	1,800	
..	1	..	1	..	1	..	..	1	"	5,500	
..	1	1	..	..	1	1	..	..	16 75	3,300	
..	..	..	1	..	1	..	..	..	17 25	400	
..	1	..	..	..	1	..	..	..	17 00	700	
..	3	2	1	..	..	..	..	..	"	20,745	
1	..	4	1	1	5	..	..	..	"	4,740	
..	3	..	..	..	2	1	..	..	"	945	
..	..	..	1	..	..	..	..	1	..	..	
..	1	..	1	..	2	..	..	..	17 60	1,100	
..	2	1	..	..	2	..	1	..	"	2,200	
..	4	2	6	..	2	..	4	6	17 00	25,400	79,53
..	..	..	..	..	..	..	..	..	17 00	44,100	
..	..	..	..	..	..	..	..	..	17 40	19,300	
..	..	..	..	..	..	..	..	..	16 50	8,200	
..	..	..	..	..	..	..	..	..	"	10,400	
..	..	..	..	..	..	..	..	..	"	11,000	
..	..	..	..	..	..	..	..	..	..	5,000	98,000
..	..	..	..	..	..	..	..	..	16 50	30,000	
..	..	..	..	..	..	..	..	..	16 00	7,700	
..	..	20	..	14	6	..	..	..	15 to 17 50	18,000	
..	..	..	..	..	..	..	..	..	..	15,000	
..	..	..	..	..	..	..	..	..	..	5,000	75,700
..	30	..	5	..	34	1	..	5	15 40	60,900	
..	15	..	14	..	26	1	..	2	16 00	57,900	
..	11	..	1	..	11	1	..	..	17 00	15,000	133,800
1	41	..	19	..	60	1	..	..	17 00	120,000	120,000
..	..	3	..	..	3	..	..	..	16 00	9,100	
..	1	..	..	..	1	..	..	..	16 50	700	
..	..	..	..	..	..	..	..	..	..	72,700	82,500
..	6	5	12	6	5	12	..	..	18 00	16,000	
..	1	..	..	..	1	..	..	..	"	2,000	
..	..	1	1	..	1	1	..	..	"	1,000	
1	..	..	..	..	1	..	..	..	"	500	19,500
..	4	..	..	..	4	..	..	..	16 00	2,000	2,000
..	..	..	..	..	..	..	..	..	15 00	10,800	10,800
..	..	..	..	..	..	..	..	..	16 00	6,000	
..	..	..	..	..	..	..	..	..	"	6,500	
..	..	..	..	..	..	..	..	..	"	15,000	
..	..	..	..	..	..	..	..	..	"	12,700	
..	..	..	..	..	..	..	..	..	"	5,600	45,800
3	178	50	83	21	205	41	25	21			886,630

The Guillaume or Des Plantes River is bounded from the upper to the lower fall by high banks, and from its junction with the Chaudière to the greater fall, more than a mile from the high road, its course is successively over serpentine, diorite and crystalline schists. The bed of this rapid stream, which is filled with boulders and pebbles of various dimensions, has been advantageously wrought for gold by the country people, and Dr. James Douglas also undertook some years since a regular working above and near the little fall. This was, however, abandoned after having yielded $2500 to $3000 in gold. The washing of pans of gravel from the bed of this stream generally yielded grains of gold, with the black sand which ordinarily accompanies it in this region. A company of five, labouring for 20 days at a point a little above the working of Dr. Douglas, obtained between 8 and 9 oz. of gold from the gravel accumulated in the re-entering angles and cracks of the diorite. At the same time, another company working somewhat higher up got little or nothing. At this latter place the auriferous gravel was found resting not on the bed-rock but on the bluish clay; and, so far as has been observed in Lower Canada, the alluvions overlying the clay are generally poor. The gravels between the lower fall and the Chaudière have not been examined, on account of a mill to which the working would be prejudicial.

Up to 1866, the Gilbert or Touffe-des-Pins River had been the scene of the most important workings, and had yielded the largest amount of gold. In ascending this stream, which is a torrent at certain seasons, but easily examined during the dry summer, are found the remains of workings undertaken, 16 years before, by Dr. Douglas, which then furnished considerable quantities of gold, and would not have been abandoned but for the want of skilful management. A company of miners took up this old working in 1866, but their explorations were not long continued, notwithstanding certain satisfactory results, among which may be mentioned a nugget of 6 oz. weight.

On the concession De Lery is a rich deposit of alluvial gold which has been recently (1866) wrought. An excavation made by Michel to determine the limits of this deposit was rectangular in form, 8 by 12 ft., and was carried to the bed-rock, a depth of 7 ft. Three distinct layers were met with: first, 1 ft. of sandy vegetable soil; second, a yellowish sand with pebbles; third, a clayey gravel containing gold, the latter layers having each a thickness of 3 ft. The washing—by means of a rocker—of 100 cub. ft. of this gravel, gave only 17 gr. weight of gold, the greater part of which was extracted from the fissures of the sandstone which formed the bed. About 40 fathoms further up the stream, a company undertook explorations, which employed 6 workmen, cost $300, and gave but 2 oz. of gold; yet 4 miners extracted 3 oz. of gold in a week, from an excavation not 25 ft. to the right of this spot.

The rich alluvions of the Gilbert, which were wrought in 1863 and 1864 with considerable success (although the results were exaggerated by the spirit of speculation), are now (1866) considered to be exhausted. They were found on the lots 16 to 20 of the concession De Lery. To form a notion of this area, the deposit may be regarded as enclosed in a rectangle, having for its length the breadth of the lots just mentioned, and for its breadth a measure of 180 ft., including the width of the river and a distance of 80 ft. on either side. This area is divided like a chess-board, into squares, each of which is occupied by a working. Many of these squares have been wrought with profit, and some have given results of exceptional richness, while the yield in the adjacent squares has been much less, many not having paid the expenses of excavation; thus showing both the irregularity of the working and the irregular distribution of the gold over the area.

In 1863 there were 100 to 120 gold-miners on the Gilbert, divided into companies of 4 to 10. Their workings consisted of a series of open excavations 10 to 15 ft. deep, and of dimensions varying according to the number of workers. These open pits were sunk side by side, without method or regularity. While large quantities of gold were extracted from these excavations, a great quantity was lost and left behind. The walls, often of considerable thickness, which separate the different pits, constituted in themselves a considerable volume of untouched alluvion; and to this must be added the gold which was lost by imperfect washings. In 1865, a wooden flume, 1800 ft. long, 4 ft. wide, and 3 ft. deep, was constructed to carry away from a higher point the waters of the stream, thus leaving its channel dry, and, at the same time, to afford water for washing the alluvions. After an expenditure of about $15,000 (3000*l.*), the owners made an open cutting in the dried-up bed of the stream from lot 16 to lot 18, and extracted thence about $2500 (500*l.*) in gold.

A fact which is not without importance for the future of gold-mining in Lower Canada, is the subterranean working of the alluvions during the winter season. This was attempted in the winter of 1864–65 by about 30 miners, divided into companies of 4 to 6. By the aid of pits and galleries, they were able to carry on their search for gold throughout the winter, and to extract and wash a large quantity of gravel, in which the gold was so abundant as to richly repay their energy and perseverance. Amongst others was a mass of gold weighing a little over 1 lb. The pits on the Gilbert, 15 in number, and all on lot 18, were opened on the left bank, at distances of 50 to 100 ft. from the stream, and sunk to the bed-rock, a depth of 20 to 25 ft. They were connected by galleries, one of which, draining the whole of the works, carried the water into a pit, whence it was pumped into the river. The auriferous materials were washed in rockers, generally at the bottom of each pit. Some gold was found in the gravel which covered the slates and sandstones, but the greater part was extracted from the fissures in these rocks. The same was true in most of the rich workings on this river, and particularly on lots 19 and 20, where, of two layers of gravel, separated by a stratum of bluish or yellowish clay, only the lower one was auriferous. The bed-rock, formed of interstratified clay-slates and sandstones, is sometimes broken up to the depth of 5 or 6 ft.; in its joints and between its laminæ, where the gravel has penetrated, and often become indurated, gold has been found in the greatest abundance, and in the largest masses.

It seems to be established that the rich deposit of the Gilbert River has for its upper or northern limit lot 21 of the concession De Lery beyond which point, so far as examined, the alluvions, although generally more or less auriferous, are not workable. The irregularity in the distribution of gold in the gravel is noticeable throughout the region, but appears more marked on the Gilbert than elsewhere.

Although the greater portion of the gold which has been found here is in small grains and scales, masses have been found from 1 oz. up to 5 oz., and even 1 lb. in weight. It appears, from the smooth, rounded and worn condition of its surface, that the original source of this gold must be somewhat remote. Michel remarked that where the layer of gravel is found resting on the bluish clay with boulders, it is poor, but becomes richer when reposing directly upon the bed-rock; while in the case of two layers of gravel separated by a stratum of this clay, the upper layer is generally without gold, while the lower is more or less auriferous. The constant absence of gold from these clays, which are associated with the auriferous gravels, was certified to him by numerous miners, and confirmed by the washing of no less than 100 cub. ft. of the clays taken from his exploring pits at different levels, and even from the surface of the bed-rock itself. These clays, however, contain, besides numerous pebbles and boulders, notable quantities of cubic pyrites, black ferruginous sand, and grains of garnet.

Alluvial gold has also been found in the greater part of the streams falling into the left bank of the Chaudière, and among other places in the townships of Tring, Shenley, and Dorset, and in the river Bras.

The district drained by the waters of the Famine and Du Loup, as far as the frontier of Maine, has been the subject of numerous explorations. The richness of the alluvions of the Du Loup was shown by the workings at its confluence with the Chaudière in the years 1850–51–52. All the tributaries of the Du Loup hold the precious metal in their sands; and it has also been found in many of the tributary streams of the Chaudière in the townships of Jersey and Marlow.

The existence of gold has been reported on the River Magog above Sherbrooke, also along the St. Francis valley, from the vicinity of Melbourne to Sherbrooke, and in the townships of Westbury, Weedon, and Dudswell, as well as on Lake St. Francis.

It would appear from the results of Michel's examinations, as well as from the information received from the country people who have sought for gold in this vicinity, that although the alluvions of the Magog may be said to be auriferous, the precious metal in them is in too small quantity to warrant working. Exceptionally rich deposits, which are found in all alluvial gold regions, and of which that of the Gilbert is a striking example, may however of course be met with.

The rule which appears to govern the distribution of alluvial gold in all other regions where it has been wrought, holds good in Lower Canada. Here, as elsewhere, the layers of alluvion which contain the precious metal are not continuous, but occur in sheets or belts of greater or less extent, and of variable thickness. The proportion of gold in these sheets or belts is also far from uniform and regular, the richer portions being met with in patches more or less remote and isolated from each other. The auriferous gravels appear, from their composition and distribution, to result from a general alluvial action. In the crushed and pulverized veins of the neighbouring hills, which make up the auriferous alluvions of the valleys, the gold is often so capriciously and irregularly distributed that the results of a week's working in some favoured spot will amply compensate the miner for months of unprofitable toil in poorer ground. These general facts are illustrated by the rich deposits met with in several places of the Chaudière region, as at the Des Plantes, Gilbert, and Du Loup, and it can hardly be supposed that in so vast a region, these are exceptional cases. From these considerations, Michel deems it proper to encourage the search for alluvial gold, in the hope of discovering other rich deposits, especially when such workings may favour the discovery of the veins which have furnished the precious metal.

Quartz Veins.—The old rock formations, upon which the gold-bearing alluvions of Lower Canada repose, contain numerous veins or bands of quartz, which run ordinarily in the direction of the stratification, N.E. and S.W. Although these veins, with their encasing rocks, present numerous outcrops, they are concealed from view, over large areas, by a covering, variable in thickness, of vegetable soil or other superficial deposits, so that trenches or excavations become necessary to follow their course. It is especially in the slates and sandstones of the Upper Silurian series that these veins have been observed in the greatest numbers. The thickness and aspect are very variable. The quartz, however, is generally white, although sometimes coloured by oxide of iron, apparently due to the decomposition of some foreign mineral, which has given to the mass a cavernous or carious structure. Some of these veins seem almost free from foreign minerals, while others contain metallic sulphurets, such as cubic pyrites, arsenical pyrites, blende, argentiferous galena, and sometimes native gold. It appears also from the analyses published by the Geological Survey that the pyrites and blende are sometimes auriferous.

The Reports of the Survey have shown the presence of native gold both in the veins belonging to the crystalline schists of the Lower Silurian near Sherbrooke, in Leeds, and in St. Sylvester in the seigniory of St. Giles, and in those traversing the Upper Silurian rocks in the seigniory of Aubert-Gallion (St. George), and in that of Vaudreuil at the Devil's Rapids in the Chaudière. While thus establishing the presence of gold in the veins of both the upper and lower formations, both of which might have contributed to the auriferous alluvions, the Reports express an opinion that the greater part at least of the alluvial gold of Canada is derived from the Lower Silurian rocks. In support of the facts just cited, several specimens containing visible grains of native gold in vitreous copper have been extracted from a quartz vein which crosses the two concessions known as "The Handkerchief," in the seigniory of St. Giles. But inasmuch as visible gold has also been found in the veins of the Upper Silurian rocks, and as the largest specimens of gold in the gangue yet found in Canada are from the vein at the Devil's Rapids, Michel believes it desirable to explore carefully all this part of the auriferous region, in the hope of favourable discoveries.

A[illegible]gh the veins attracting most attention are in the seigniory of Vaud[illegible] numbers of similar quartz veins are found all the way southward to the frontier ; and many have been discovered in the seigniories of Aubin-Delisle and Aubert-Gallion, and in the townships of Jersey, Marlow, Linière, and Metgermette. Several outcrops of quartz appear along the Kennebec road ; and at low water many of them can be seen in the beds of the Famine, Du Loup, and their tributary streams, such as the Oliva, the Metgermette, and others.

The townships and seigniories which are the subject of the preceding remarks, are on the right bank of the Chaudière ; but the veins for the most part appear to cross the river, for many outcrops of them occur on the road from St. Joseph to St. George, as well as on the shores and in the bed of the Chaudière. Several of these have already been followed, and uncovered on the left bank, especially in Vaudreuil and Aubert-Gallion. Other outcrops are seen on the road from Vaudreuil to Lake St. Francis, in the townships of Tring, Forsyth, Aylmer and Lambton.

Of the specimens of quartz veins collected by Michel and assayed by Dr. Hunt, the following are worth recording :—

1. Vaudreuil, lot 21, concession St. Charles: powerful vein, running N.E., with very slight S.E. dip ; 18 ft. wide. Gold, mean of 4 assays,

6 dwt. 13 gr. = $6 76c. (28*s.* 2*d.*); another sample, with visible gold, 4 oz. 18 dwt. = $101 29c. (21*l.* 2*s.*); average of 5 assays, $25 66c. (5*l.* 6*s.* 11*d.*) per ton.

2. Vaudreuil, lot 19, concession St. Charles: vein in clay-slate, running N.E. with S.E. dip, 24 ft. thick at outcrop. Gold, mean of 4 assays, 4 dwt. 21 gr. = $5 3c. (20*s.* 11*d.*); mean of 2 others, with visible gold, 3 oz. 2 dwt. = $64 7c. (13*l.* 6*s.* 11*d.*); mean average, $24 71c. (5*l.* 2*s.* 11*d.*) per ton.

3. Vaudreuil, lot 20, concession De Lery: vein 7 to 8 ft. wide between clay-slate walls, running N.E. with S.E. dip. Gold, mean of 2 assays, 14 dwt. 16 gr. = $15 15c. (3*l.* 3*s.* 1*d.*) per ton.

4. Linière, lot 2, range 1: mass consisting of several veins 4 to 6 in. and even 1 ft. wide, with intervening portions of wall-rock, running N.E., with S.E. dip. Gold, mean of 2 assays, 6 dwt. 13 gr. = $6 76c. (28*s.* 2*d.*) per ton.

With regard to gold in Lower Canada, Michel arrives at the following conclusions:—

1. The auriferous deposits which cover a great region in Lower Canada, in all probability contain, particularly in the valley of the Chaudière, considerable areas whose regular and methodic working on a large scale by hydraulic processes may be made remunerative; in addition to which, limited deposits of exceptional richness, such as have been already found, may be looked for.

2. Although the examination of the alluvial gold from the deposits hitherto worked does not permit us to attribute its source to veins of quartz in the immediate vicinity, it is nevertheless established that this alluvial gold is derived from the rocks of the region.

3. The existence of native gold having been established, alike in the veins of the altered Upper and Lower Silurian rocks of the district, the search for gold-bearing veins should not be confined to a few localities, but may be extended with probabilities of success to the whole area occupied by the altered rocks of these two divisions.

An elaborate report on the Leech River district was prepared by Dr. G. M. Dawson, in 1876–7. Leech River was discovered to be auriferous by R. Brown's Government exploring expedition, in the summer of 1868. It attracted much notice, and it is estimated that about $100,000 (20,000*l.*) worth of gold was obtained from it in a comparatively short time. Houses and stores were erected under the supposition that it would prove a permanent mining region, but it is now abandoned.

Very little gold has been found on the Sooke River, above its junction with the Leech; while, below, scales of gold occur on all the bars. On the east and west reaches of Leech River, the greater part of the gold was obtained, and, in turning up the North Fork, it rapidly diminished in quantity,—no pay being found above a fall known as the Devil's Grip.

The east and west portions of the Leech take their course along the strike of soft, blackish schists, which appear to form the southern margin of the slaty belt, and to these dark rocks must be attributed the greater part of the gold. The valley is narrow, in places almost V-shaped, and rises very steeply on its southern side, which appears to be formed by hard trappean rocks. While the strike of the soft rocks explains the course of this part of the river, its northern branch, and the north and south direction of the Sooke, seem to be due to remarkable systems of parallel cracks, which have affected the rocks without causing much displacement, and are best exemplified at the cañon on Sooke River.

Although the southern portion of the belt of schists appears to be characterized by the preponderance of blackish beds, there are also considerable intercalated masses of greenish-grey rocks, like those of Goldstream Bridge, and the general appearance of the beds near Kennedy Flat is so precisely that of those of the Bridge and its vicinity that there seems no reason to doubt that the same horizon is represented in both places. At the mouth of Wolf Creek—joining the Sooke from the east, nearly opposite Kennedy Flat—the compact trappean rocks are again found bordering the slaty belt to the south. The material is here a fine-grained felsitic trap or indurated volcanic ash, shot through with epidoic seams and stains. Its dip is N. 10° E. ∠ 54°, being almost opposite in direction to that previously observed in these rocks near their junction with the slates. In following the auriferous belt to the North Fork, the rocks were observed to have the following attitudes in order from east to west: — Dip N. 17° E. ∠ 45°; dip N. 22° E. ∠ 60°; dip N. 30° E. ∠ 80° to vertical; dip N. 17° E. ∠ 80°; dip N. 22° E. ∠ 70°; dip N. 20° E. ∠ 80°; strike S. 58° W., vertical.

In all parts of the slaty belt quartz veins abound, and in the black schists of Leech River are especially numerous, though small. A band of slates is often characterized by small thin streaks of quartz, and little lenticular bunches through all its layers, without showing any well-marked large vein. The quartz holds little pyrites, though it is sometimes superficially rusty, and Dr. Dawson could not learn that gold had ever been found in any of the veins. Just north of Kennedy Flat is a broad quartz band, resembling a lode, but which, from its lamination and compact aspect, more probably represents a zone of the slaty rocks silicified. It contains no metallic minerals.

Adding to the east and west reach of the Leech River, about 1½ miles of the North Fork, the total length of the stream on which gold in any quantity has been found is about 5 miles. As far as Dr. Dawson could learn, all the good "pay" was obtained in cleaning up the bed of the river itself, and by "crevicing" in the pot-holes, pockets, and fissures of the slates of the sides of the valley. This distribution of the gold seems to follow naturally from the steep sides of the valley and its small width, and it does not appear that rich finds were made on any of the terraces and banks far above the stream, though a good deal of prospecting work was done on some of them. The greatest quantity of heavy gold seems to have been obtained near Bacon Bar, about half-way between North Fork and Kennedy Flat. At the last-named locality, the gold was nearly all light and scaly.

Judging from appearances, the gold of the Leech River rocks has been pretty generally diffused in small quartz seams, through certain parts of the slaty rocks, of which a great mass has been worn down and removed during the excavation of the valley, leaving the heavy gold, by a natural process of concentration, in a narrow line in the bottom of the excavation. It may, therefore, very well be that no veins exist suitable for mining operations, though the deposits of the valley have been so rich in some places. At the same time, the finer particles of gold are very generally diffused through all the surface deposits, and one can generally find 2 or 3 "colours" to a pan of dirt taken from the modern deposits near the river level, or from the decomposed "cement" far up the slopes.

Little pyrites is found in association with the gold, and no particles of galena were observed; while magnetic sand is also present in rather small quantity, especially on the lower part of the river near its junction with the Sooke. In quality, the gold is remarkably good.

There is little doubt that some rich spots yet exist in the neighbourhood of Leech River; but they must be comparatively quite limited in extent, and, from the nature of the country, difficult to find. Dr. Dawson was told that, in most cases, the miners were content to go no lower in the bed of the Leech than the surface of the cement, which in some places passes completely under it. In this case, it is highly probable that an auriferous horizon, at least equally rich with the upper, exists on the surface of the true bed-rock. The steep-sided character of the valley precludes the possibility of the existence of extensive old channels following different courses from the present stream; but, on the south side of the river, near its mouth, a gravel flat occurs, where, in the opinion of miners, the river at one time flowed. This opinion may very probably be well-founded, and if the ground is not very difficult it might be worth testing it. It is also not improbable that, by hydraulic work, a great part of the cement and benches near the river would be found remunerative. The possible existence of auriferous veins—rich enough to pay for working in this part of the country, which, in respect to its position, has great advantages over the inland districts—should also be borne in mind, though nothing of a very encouraging nature can yet be said on this subject.

In regard to the general relations of the auriferous belt, it may be stated to intervene between the dioritic and felspathic rocks of the Victoria series on the north, and the traps, amygdaloids, and breccias of the Sooke series on the south, though its relations to either of these systems cannot yet be certainly stated.

Though rather irregularly distributed in the slaty belt, gold, in paying quantity, is probably confined to it; which renders its definition, both on the map and in its relations to the neighbouring rocks, a matter of some importance. It is quite possible that several parallel folds may occur within the width of the belt of gold rocks, and that variations in its width and character may depend partly on these. In only two places has the attitude of the rocks of the Sooke series been ascertained near their junction with the gold rocks. In one case, they dip in a direction almost exactly opposite to them; and, in the second, dip with them, and might be supposed to pass under them conformably.

Copper ores and gold are intimately associated in the following localities:—In Lake township, where the diorites, green slates, dolomites, and mica-slates are very extensively developed, copper ore occurs in a great number of localities, and with it gold is always intimately associated. At the Richardson gold-mine—Madoc,—on lot 18 in the 5th concession, both the yellow and purple ores of copper are associated with the greenstone which occupies the western portion of the lot, while towards the centre of the eastern portion gold was at one time obtained in large quantities from the "gossan" which filled the crevices in a very cavernous ferruginous dolomite. Here it was also closely associated with white finely-granular mispickel or arsenical pyrites, through which yellow sulphuret of copper was disseminated. At the Empire mine, at Madoc village, tetrahedrite was found irregularly distributed through a very siliceous brown weathering dolomite, and was both auriferous and argentiferous, some of the analyses indicating large percentages.

In Marmora, copper ore was found in traces in a number of localities along the western margin of the granite area known as the "Huckleberry Rocks," and here it was associated with mispickel, which is highly auriferous, but contains little silver.

At Elzevir, in the vicinity of Bridgewater, copper ore again occurs in a number of places, and also gold in small quantity.

In the south-eastern corner of the township of Palmerston, a rather important vein, carrying a large proportion of copper pyrites, was met with on the western half of lot 2 in the 9th concession. It is closely associated with dark-greenish hornblende rocks, and some glossy and rusty mica-slates, and the gangue is largely composed of translucent quartz, which appears to be divided into layers by intervening strings of iron and copper pyrites. Calcite also occurs abundantly in bunches and layers. Oliver, of Perth, who is interested in this location, says that gold is found by analysis to be present in sufficient quantity for profitable extraction. No official analyses of the ore have yet been made.

From an extremely interesting report by Richard P. Rothwell on the Canada Consolidated Gold Mining Company's mines, it appears that about 30 miles north of the city of Belleville (which is situated on Lake Ontario), and in the township of Marmora, Ontario, is found a belt of gold-bearing quartz veins, which have been shown to contain immense quantities of ore of a highly profitable quality. The mines are situated on the Moira River, in a well-wooded, rolling, agricultural country, where the roads are good and level, and the distance to the railroad, at the town of Madoc, is about 10 miles, and to Stirling, on another railroad, is about 16 miles.

The gold-bearing veins are quartz-filled true fissures in syenitic granite, with micaceous or talcoid slates forming the walls of, and horses in, the veins. This talcose slaty rock is the product of the chemical decomposition of the syenite along the fissure, where it and quartz form the gangue for an arsenical gold-bearing iron pyrites (mispickel). The magnesia of the talc comes from the hornblende in the syenite. The mispickel is found generally in a crystalline form, though sometimes in heavy amorphous masses running in beds through the quartz. Considerable quantities of crystallized calc-spar occur irregularly in the veins.

Some 4 or 5 parallel veins have been proved to exist in a belt of 500 or 600 ft. in width, running through the property of the company for a length of over ¾ mile, while the main vein has been opened on adjoining properties, making a total proved length of this great fissure of about 3 miles on the vein, a fact which, next to actual sinking, may be considered the best proof of the continuance in depth of the veins. Three of these veins have been proved on this property by costine pits and shafts sunk at short intervals along their outcrops, to depths varying from 15 to 150 ft. In this manner, the east or main vein has been thoroughly explored over a length of about 800 ft. by shafts of 40 to 150 ft. in depth; these have, in every case, been in pay-ore all the way; their lowest points are now in as good ore as has been found on the property; and they have shown this vein to have a thickness exceeding 20 ft. in many places, and averaging probably 10 or 12 ft.; while the middle and west veins, though smaller, have still apparently a thickness of 3 ft. and upwards. On the Hawkeye property, the west vein has been opened to a width of about 12 ft. at a depth of about 60 ft.

The gold is found as free gold principally in the arsenical sulphurets, but it occurs also in the quartz, where it is often plainly visible. The proportion of sulphurets to quartz in the vein has been ascertained by repeated tests; it varies from 10 to 60 per cent. in weight of the entire vein-stuff, and these sulphurets carry from 30 to several hundred dollars per ton, while the entire filling of the vein, without any sorting whatever, has been found, by careful sampling of over 600 tons in 5-ton lots, to run from $10 to $25 (2*l.* to 5*l.*) gold per ton and average about $20 (4*l.*). Selected samples have been found to carry over $1000 (200*l.*) to the ton; but the conclusions arrived at have been based solely upon working results, on large quantities of the ore treated just as it came from the mines without any selection whatever, and they are believed to represent figures which will be realized steadily in actual working operations.

The veins are beyond all doubt true fissures in syenitic granite—very similar to the mines of Cornwall, Saxony, and other parts of the old world, where they have been worked with profit for hundreds of years—while their great proved length and thickness on this property put beyond any reasonable doubt their continued productiveness to the greatest depths.

It is not, of course, expected that the veins will be of uniform thickness throughout, or that the ores will be equally rich in every place; on the contrary, the fissures will open out in some places and pinch in others, and the ore itself will be far richer in some parts of the vein than in others; but the fact that not a single one of the 5-ton samples (representing over 600 tons) carried less gold than would leave a handsome profit after deducting the cost of mining, milling, and loss in treatment, justifies the belief that pay-ore will be found throughout the entire length (nearly 1000 ft.) already proved of the main chimney.

The ores are in that condition in which they occur to the greatest depths, and their richness, with the usual fluctuations, has thus far increased as depth has been attained. The yield is more than double that of the Homestake, Black Hills, Dakota, ores (that come from somewhat similar veins) which have paid such magnificent returns during the past two years, that the stock of that company is even now (August, 1880), when every mining stock is depressed, selling at the rate of over $3,000,000 (600,000*l.*) for the property.

Gold was first discovered in the Marmora district in 1865, as free gold in quartz and mispickel, and sporadic attempts have since been made at two or three points to treat the ores, chiefly by raw amalgamation. As might have been anticipated from the nature of the ore, but a very small proportion of the gold was saved in this way; while the expense of treatment in the little primitive mills adopted was great, and the loss of quicksilver was heavy. There was neither experience nor technical knowledge available at the time, and no sufficient capital to put up suitable works or to develop the mines; hence they have lain idle all these years without a single serious effort to work them on an economical basis. Nevertheless, many tests of the ores were made, some on quite an extensive scale, in reduction works in the United States and England, and the results were invariably highly satisfactory; so much so, indeed, that the owners of the only developed properties, though financially unable to work the mines themselves, esteemed them so highly that they would not sell at such a price as would offer an inducement for others to purchase. By consolidating a large number of tracts, and thus making a property of sufficient magnitude to justify the establishment of large works, these valuable ores have been made available.

Assays of average samples quoted by Rothwell show the presence of gold in proportions varying from $15 to $100 (3*l.* to 20*l.*) per ton (of 2000 lb.), when dealing with large lots (several tons) of the undressed ore; while samples of the pure mispickel reached $753 (150*l.*) and even $2920 (584*l.*) per ton of 2000 lb. The crushed and concentrated ore is roasted in a revolving furnace, and chlorinated or amalgamated.

An auriferous quartz vein, on which a shaft has been sunk by the Shebandowan Mining Company, exists on location H, near Jackfish Lake, lying 15 miles west of Shebandowan Lake. At this shaft, the vein has a width of 5 ft. of solid quartz, which, however, divides into three branches to the north-eastward. The vein carries considerable quantities of copper and iron pyrites, galena and silver glance, and is rich in visible gold. Numerous assays of the ore show very rich proportions of both gold and silver, but it has not yet been tested on a large scale. In the neighbourhood of the shaft, this vein is enclosed in soft talcoid slate, which is flanked on either side by chloritic slates. These again are associated with dioritic, argillaceous, siliceous and porphyritic slates, and also with massive diorite, porphyry, slate-conglomerate and granite. There are likewise bands of magnetite and quartzite. On location H, the vein has been proved for nearly ½ a mile, and its apparent continuation has been traced for about 8 miles farther, varying greatly, however, in richness. Its general course is about N. 60° E. (ast.), while the slates, which dip northward, at angles varying from 60° to 80°, run rather more easterly, so that the vein intersects them at a small angle, and varies in character in crossing the different bands. The formation is Huronian.

In a location on Partridge Lake, a small sheet of water a few miles west of the western arm of Lac des Mille Lacs, the vein consists of white quartz, averages 5 ft. in width, and runs north-eastward with the strike of the talcoid schists which enclose it. Greenish mica-schists with the same strike are met with on the south side of the lake, while granite occurs on an island a short distance to the north of the vein. The vein holds iron and copper pyrites, besides the gold, which occurs in disseminated grains. Specimens assayed in the Geological Survey laboratory contained about $30 (6*l.*) worth of gold to the ton of 2000 lb. No trials have as yet been made on a large scale.

An outcropping vein at Victoria Cape, on the west side of Jackfish Bay (opposite to the Slate Islands), Lake Superior, is 1½ to 3½ ft. thick, and runs N. 55° E. It is heavily charged with iron pyrites, and also holds galena and blende. The country-rock is a light-red granite with green dioritic slate in close proximity to it. The discovery of gold in this locality was only made last summer, but the vein has been uncovered for a distance of 500 ft., and shows a vertical section of 60 ft. in a neighbouring cliff. An average of assays of the white and the dark parts of the veinstone gave $27 (5*l.* 8*s.*) gold and $7.78 silver per ton. A smaller vein, a short distance S.E. of the above, yielded $140.33 (28*l.* 1*s.* 4*d.*) gold and $17.62 (3*l.* 13*s.* 5*d.*) silver to the ton, and shows free gold.

A sample received from Pèche village, Wakefield township, Ottawa county, was a white (with occasionally a bluish or greyish tinge), translucent quartz, traversed by small veins of a light-green coloured apatite, and in parts coated with hydrated peroxide of iron. Native gold was readily discernible; it occurred sometimes in the quartz, and at other times in the oxide of iron, or else at the junction of the two. The assay gave 11·725 oz. of gold per ton of 2000 lb., and 52·323 oz. silver.

Another sample from the northern point of a large island in the Lake of the Woods, about 12 miles south-east of Rat Portage, was a quartz penetrated by delicate needles of hornblende, with some greenish chloritic matter, and a little calcite. It contained distinctly visible gold, and assayed 37·318 oz. of gold per ton of 2000 lb., and 1·431 oz. silver.

The official statistics of the exports of gold-bearing quartz, gold-dust, nuggets, &c., from the dominion of Canada in 1872-79 were as follows:—1872, 257,175*l.*; 1873, 215,678*l.*; 1874, 223,734*l.*; 1875, 334,539*l.*; 1876, 306,675*l.*; 1877, 247,724*l.*; 1878, 214,898*l.*; 1879, 196,686*l.* It is impossible to say what proportion of this was contributed by British Columbia and other districts outside Canada proper, or what quantity found its way to San Francisco overland, and became included in United States statistics.

Manitoba and the North-West Territory.—Dr. Harrington found traces of gold in the iron pyrites which Dr. Bell collected (1877) from a small vein cutting the gneiss on a point about one mile south of Great Whale River; also from that in other small veins in the dolomite which forms Dog Island, close to the main shore, a few miles north of Cape Jones. The drift of the Little Whale River valley appeared to show indications of alluvial gold, but numerous pannings at the first fall and elsewhere failed to bring any of the precious metal to light.

When gold was found in the Saskatchewan River, near the Rocky Mountains, it was presumed to have been washed from auriferous veins in those mountains. But this view proved incorrect. Professor Hind, who explored the country for the Government in 1858, says in his report that he discovered in St. Martin's Lake, a small sheet of water lying between Lakes Manitoba and Winnipeg, gneissoid rocks, traversed by quartz and felspathic veins, and that these being gold-bearing rocks, he searched for it; but nothing was found, probably owing to the lack of time. The deduction which he draws from the later discovery of gold on the plains of the Assiniboine is, that the precious metal has been conveyed with the drift from ranges of gold-bearing rocks running parallel with the Lake Winnipeg basin, and the Laurentian formation on the eastern side of the lake, and extending to the north-west beyond Lake Athabasca. He considers it certain that all over the drift of the plains, from Lake Manitoba to the Rocky Mountains, gold will be found; though, as a matter of course, the wideness of the field can only be ascertained by actual mining operations. Governor Dallas is said to have washed gold at Fort Edmonton, on the Saskatchewan.

On hearing of the discoveries on the Saskatchewan, &c., Dr. Hector, who accompanied the Palliser Exploring Expedition, gave it as his opinion that the gold deposits had been washed from the shingle terraces along the eastern base of the mountains, where, it is believed, the precious metal is most abundant.

On ascending the Saskatchewan, there is a gradual disappearance of the boulders of granitic, gneissic, and other crystalline rocks, simultaneously with which the auriferous character of the drifts likewise dies out; and Selwyn was credibly informed that no gold could be found on the North Saskatchewan above Rocky Mountain House, though it had frequently been prospected for by experienced miners. The first gold-washings which he saw in descending the river were rather more than 40 miles below the mouth of the Brazean; and thence to Edmonton, and for some miles further down, more or less gold has been found on the bars, and in the river banks, but always in a very finely divided state, showing evidence of having been transported from afar. Even as far down as Carlton, gold can, he believes, be found, though not in quantities sufficient to pay for working. On the South Saskatchewan, at the crossing-place, about 20 miles S.E. of Carlton, he washed out a few minute specks of gold from the gravel in the bed of the river—small red garnets, with a considerable quantity of magnetic iron sand, constituting the bulk of the residue in the pannings. It would thus appear that the gold of the Saskatchewan has not been derived from the mountains at its source, but from the drifts composed of granitoid gneiss, with hornblendic and micaceous schist, quartz and limestone, which are spread over the face of the country for hundreds of miles, and which must have been themselves largely derived from the denudation of the great belt of Laurentian and other crystalline rocks, which extends from the shores of Lake Superior north-westerly to the Arctic Sea.

The fact that the general direction of the glacial striæ is S.W.-ward, and the drift derived from rocks *in situ* N.E.-ward, have an important bearing in tracing any useful mineral, which may be found in the drift, to its parent source. As just stated, no gold has been detected in the streams forming the sources of the Saskatchewan, in the Rocky Mountains, or near their eastern flank, while it has been traced in the North Saskatchewan and its northern tributaries, from the neighbourhood of Rocky Mountain House to the Forks. Bell was informed by various miners, who have spent much time in exploring, that they have detected fine gold in almost every stream they tried between the two great branches of the Saskatchewan from the longitude of Edmonton to the Forks. He himself found minute specks at the Elbow of the South Branch, and at one place in the Red Ochre Hills. As far as known, however, the gold appears to be most abundant about Edmonton. It is, no doubt, washed out of the drift, and as there is little probability of its having come from the unaltered strata underlying the plains, it is to be inferred that it has been derived from the crystalline rocks to the N.E.-ward, probably somewhere between the Methy Portage and Athabasca Lake. These rocks lie at a distance of only about 250 miles from Edmonton in that direction. Free gold is known to occur in veins in the Huronian rocks to the north and north-west of Lake Superior. The bands of Huronian rocks in all this region run in a south-westerly direction, or at right angles to the general trend of their outline from Lake Winnipeg to Lake Athabasca. Sir John Richardson, in his "Journal of a Boat Voyage through Rupert's Land," mentions the occurrence of rocks corresponding with the Huronian gold-bearing bands; and it appears probable that they run in belts having a south-westerly course. He is therefore of the opinion that the gold found about Edmonton is derived from veins in Huronian strata in the neighbourhood of Lake Athabasca, or between this lake and the Methy Portage. The fact of the Huronian rocks running in belts, whose direction nearly coincides with that of the drift, would account for its somewhat local distribution.

Gold has been procured, from time to time, in various places and in paying quantities, both along the Parsnip and the Peace rivers. It always occurs in very fine, uniform-sized particles, quite similar in character to that found on the Saskatchewan, and is probably entirely derived, here as there, from the Drift deposits and Tertiary gravels of Division I. (Cainozoic—Superficial deposits and Lignite-Tertiary group, including the upper volcanic series), which are cut through, washed, and re-distributed by the present river action.

The Buffalo mountains, lying south-east of Vermilion, are said to contain gold and silver, and both are reported from the neighbourhood of Fond-du-Lac.

New Brunswick.—Gold has been reported as occurring at several points in the metamorphic rocks of Albert County, but no reliable data can be obtained. Specimens of supposed gold, examined, in nearly every case proved to be iron pyrites. Many of the quartz veins, however, show traces of galena, and resemble those of the auriferous area of Nova Scotia; and the occurrence of visible gold in the quartz pebbles of the Carboniferous conglomerates of the coast would lead to the inference that diligent search may yet be rewarded, although washings made at several points by Ells did not disclose any traces of gold.

In Charlotte County, about 150 yd. north-east of the Oliver Lodge, another metalliferous vein is exposed on the top of a low ridge of chloritic diorite. The underlie of this vein is S. 35° E. ∠ 65°. It carries sulphuret of copper (chalcopyrite) in a gangue of quartz, with some calc-spar and foliated chlorite. It also contains native bismuth, native copper (in the chlorite), carbonate of copper, and sulphuret of iron. Samples of this ore, analysed under Dr. T. S. Hunt's directions, at the Geological Survey Office, in Montreal, yielded 10 per cent. of bismuth and $5 (1*l.*) to the ton of gold. The yield of copper, from samples analysed by Prof. Nichol, of Halifax, was 29½ per cent.

W. S. Shea has given a detailed account of his explorations into the gold-bearing gravels of certain river-valleys in the Counties of Victoria, Northumberland, Carleton, and York, in Central New Brunswick, and has been able to draw therefrom the following inferences:—(1) That the gold in these alluvial deposits is derived from the quartz veins penetrating the rock of the district; (2) that the gravel, which contains pebbles of all sizes, is derived from the disintegration of the rocks of the district; and (3) that, judging from the richness in gold of paying drift in California, it is probable that these auriferous gravels will pay also.

Professor Hind mentions (1865) the discovery of gold in small quantity at several points in the Nipisiguit in the drift, but in no case did the washings indicate its existence in paying proportions. Quartz veins are very numerous throughout the whole extent of the metamorphic rocks in northern New Brunswick, many of which were broken up and carefully examined by R. W. Ells in 1879–80; but no visible gold was observed in any of them. The great majority of these veins are small and irregular, and often of the nature of short gash-veins. Washings at various points frequently disclosed the existence of black sand, with which gold is often associated; but gold was not found, though many persons have been deceived by the occurrence of small scales of yellow mica and minute particles of yellow pyrites. Explorations have been carried on irregularly for a number of years, apparently without any satisfactory results.

A company, during the summer of 1879, however, professed to have found quartz in one of the branches of the Nipisiguit, that yielded gold at the rate of $5 (1*l.*) per ton; and subsequently carried on operations on the Millstream, 8 or 10 miles from Bathurst, in rocks of presumed Cambro-Silurian age, the result of which has not yet been published.

On some of the streams in the county of Northumberland, good specimens of gold-bearing quartz are reported to have been picked up several years ago; and the number and aspect of the quartz veins at several points renders the occurrence of this metal probable. On the Little South-west Miramichi, a fine specimen of gold is said to have been found, about 3 miles above the North Branch, and not far below a heavy rapid, known as Main's Ledges; while on the Main South-west, several small pieces have been obtained a few miles above Boiestown, but the locality whence these were originally derived has not been ascertained.

Newfoundland.—In his Report for 1868, Alexander Murray, C.M.G., endeavoured to draw attention to the quartz veins at sundry places in the peninsula of Avalon, from their resemblance to the recognized auriferous strata of Nova Scotia; but it is only since 1880 that any attempts have been made to prove the ground.

The formation is serpentine, belonging to what is termed, in Canadian geology, the "Quebec group" of the Lower Silurian basis, the great metalliferous formation of North America. Where no serpentine exists, it is vain to look for ore. The ore in Newfoundland occurs in beds or pockets—not in veins—and, in the localities already opened, is extracted with great facility. Howley estimates the total area of the serpentine or ore-bearing formation at 5000 square miles. Murray says that the experience of the late investigation convinces him more than ever that many of the northern parts of the island, and the great bay of Nôtre Dame in particular, are destined to develop into great mining centres, should capital and skilled labour be brought to bear in that direction. The north shore of Conception Bay, 2 miles from Brigus, and in the immediate neighbourhood of Brigus Lookout, has been the principal scene of his investigations. Here, after a careful examination, he selected a ledge of quartz which seemed the most promising. A hole was drilled underneath it, and the first blast detached 2 or 3 cub. ft. of quartz, with chloritic patches. In this mass, within an area of a single cubic foot, 10 "sights" of gold were obtained. The fragments of quartz were put into a bag, and on shaking it out afterwards, a small piece of gold weighing 4 gr. was found, which had been detached by friction in carrying it to Brigus. The quartz veins, in one of which the gold was found, are reticulated over a considerable area, and intersect a green felsite magnesian slate of the Huronian age. They vary from 1 in. to 1 ft. in breadth. The veins frequently intersect one another, and at the points of intersection form a knot or boss. It was in one of these knots that the gold was found. The quartz holding the gold particles is associated with a dark-green chlorite, and in the chlorite patches the gold is seen finely distributed. The reticulated veins of quartz are chiefly limited to an area of country nearly 1 mile in breadth, and 3 miles in length, extending from Brigus Lookout in a south-west direction. Various reports are in circulation to the effect that gold has been found at a much greater distance inland, in the same direction.

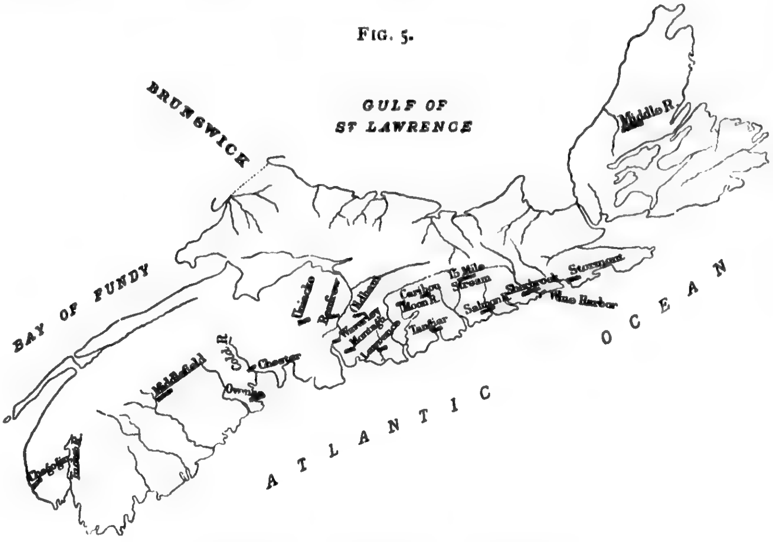
Murray also visited Fox Hill, about 2 miles from the former locality, and obtained a gold specimen which had been found there by a resident. From an examination of the district, and the evidence furnished, he is strongly of opinion that there is here an area of country 6 miles in length, and 1 mile in breadth, which, if judiciously explored and properly worked, will be found auriferous. He further says that a large area of country in the region referred to is auriferous, although nothing short of actual mining and practical experience can possibly prove what the value of the produce may be, or whether the prospects of obtaining a remunerative return for the necessary outlay are favourable or otherwise. The specimens which have been obtained, although an unquestionable evidence of the presence of the precious metal, cannot by any means be taken as indicative of a certain average yield. But the indications are certainly sufficiently favourable to merit a fair trial; and there are good reasons to hope and expect that ample capital applied to skilled and judicious labour may be found remunerative to future adventurers, while a new industry will be added to give employment to the labouring population of the island, and possibly bring this despised and but little known colony into more prominence and consideration abroad than it hitherto has enjoyed.

Nova Scotia.—All matters relating to gold in Nova Scotia have been ably reviewed by Gilpin, in his work on Nova Scotia mines (1880), and subsequent reports; it is impossible to do better than summarize from him. See sketch-map, Fig. 5.

The Atlantic coast of Nova Scotia, from Canso to Yarmouth, is occupied by a series of measures presenting a rough, undulatory surface, diversified by numerous lakes and rivers, and arms of the sea running far into the land. The width of this district varies from 10 to 40 miles, and its area may be approximated at 6500 square miles. In this district, are large belts of a rock, commonly called "granite," the limits of which have not yet been defined; but it is believed to form an irregular band, extending in a curve from Sambro to Cape Sable, and to form another interrupted belt, running from Waverley to Cape Canso. These bands are estimated by Prof. Hind to cover about one-half of the district.

Selwyn remarks that the gold-bearing series in Nova Scotia closely resembles the Cambrian and Lingula-flag series of North Wales, also auriferous. The lower members of both series, in both countries, consist of a succession of thick, bedded, greenish-grey, felspathic grits and sandstones, or quartzites, with intercalated bands of shale; and these are similarly overlaid conformably by black, earthy, pyritous slates and sandy beds. On the south-west shore, measures occur, as near Yarmouth, apparently belonging to the Quebec group.

FIG. 5.



SKETCH-MAP OF NOVA SCOTIAN GOLD-FIELDS.

Poole divides the former of Selwyn's series into two, the lower consisting of slates and grits, crumpled, contorted, and cleaved transversely to the laminæ, and holding lodes not yet found productive; in the upper, quartzites predominate, and productive lodes occur. These measures are all metamorphosed, and especially so at certain points, as Cochran's Hill, Sherbrooke district, where the slates have become steatitic or talcose schists, with rutile, garnets, &c.

This great series of strata has been thrown into well-defined east and west undulations, and again disturbed by transverse waves. The elevated points of intersection of these forces having been denuded, the lodes of gold-bearing quartz occur as sets of irregular ellipses. Prof. Whitney notices a similar connection of Californian lodes, with eroded anticlinals;

and a corresponding arrangement has been observed in the Black Hills.

The lodes present white, vitreous, opaque or milky quartz, differing very much in colour and structure, according to the varying conditions under which it is found. At Renfrew, it sometimes occurs crystallized and showing banded vein structure, or holding pieces of slate, &c. The lodes contain, as accessory minerals, arsenides and sulphides of iron and lead, blende, copper pyrites, oxide of iron, copper glance, molybdenite, native copper, sulphur, chlorite, felspar, garnets, mica, calcite, felsite, &c.; not, however, in quantities of economic importance.

Some lodes are apparently destitute of mineral matter, and hold but traces of gold. These are usually white and massive, vitreous to granular, and occur sometimes 15 ft. in thickness. The thinnest single lode worked is, perhaps, the Irving, at Mooseland, which varies in thickness from ⅛ to ¼ in. A lode 20 in. thick is considered a large one.

The gold occurs in the lodes in spots and bunches of the free metal, of every shape and size, up to 60-oz. nuggets. It is also present in the accompanying metals, as fine scales among their layers and crystals. It is stated to occur crystallized; among some specimens from Fifteen Mile Stream, Gilpin noticed one, apparently a pseudomorph after a crystal of cubic pyrites, ¼ in. square.

The precious metal is not confined to the lode; for in both slate and quartzite walls, crevices have been found holding gold, and but little quartz. Frequently where there are two or more lodes in slate, it is found profitable to crush the intervening slate also, which holds gold in laminæ, and in the almost omnipresent mispickel. The quartzite forming the hanging-wall of some lodes has also been seen to hold fine gold close to the lode.

The age of the beds holding the auriferous lodes of Nova Scotia is not yet determined. Geologically speaking they remain, in spite of many ingenious speculations, an unknown land. At first they were regarded as Middle or Lower Silurian; afterwards as Laurentian. At present, adopting the provisional divisions of the Geological Survey, they are considered of Cambrian age. The ages of these rocks, unfortunately, cannot be determined by the imperfect and ill-preserved fossils that have been found; their mineralogical characteristics are not to be relied upon for such a classification. Knowledge of the structure of the gold-fields is lamentably deficient, as well as concerning the question of the depth to which the lodes hold gold in paying quantity. Taking Tangier at the sea-level, and Mount Uniacke 560 ft. above the sea, it is unknown at the present moment what relative line they mark in the downward extension of the lodes.

Another important point in connection with the lodes is whether they are beds or true veins. The former view has been advanced by Dr. Sterry Hunt, Prof. Hind, and others, who consider them similar to the Virginia and North Carolina deposits, as described by Profs. Silliman and Emmons. On the other hand, Selwyn considers them true veins; and his view is supported by Poole.

The last-named authority remarks that mining operations are not confined to the bedded leads, for rich streaks of paying quartz have been followed in cross-leads, and in what are called "angling" leads. As a rule, true cross-leads of later age than the true leads are barren, or contain but a few pennyweights of gold. Their influence, or that rather of some so-called cross-leads, on the productiveness of a regular lead, is often remarked on; but cross-courses of later date are not always distinguished from contemporaneous connecting bands of quartz filling transverse fractures of the same age as the bedded leads. The effect of cross-leads on the productiveness of regular leads is worthy of note. For instance, at the junction of a cross-lead with the Belt lead at Montague, some rich spots gave as high as 40 oz. to the ton.

Where slates predominate, and there are few alternating beds of quartzite, the leads are almost invariably barren, or so sparsely spotted as to be unprofitable to work. Angling leads are met, which cross the quartzites abruptly, and the slates gradually, proving rich in various instances in one or other of the containing rocks.

In the working of the regular leads, inequalities characteristic of veins are met with. Late operations at Waverley exposed a regular "horse" of quartzite, and in one part of the foot-wall a roll of compact quartz 8 ft. wide, which in parts yielded handsomely. From the roll, a number of strings of gold-bearing quartz were found to ramify in all directions into the foot-wall of quartzite. One spot immediately below this roll gave 90 oz. from a lot of 5 tons; other strings in the foot-wall yielded largely. At a fault in this lead, drusey cavities contained crystals of quartz, galena, calcite, and iron pyrites. To mention one other instance, the West Lake at Uniacke contained a pocket beneath a swell in the lead 5 ft. wide, so rich that one crushing of 13 tons yielded 234 oz.

Often there is a narrow band of slate next the lead, which is called "gouge," on account of the ease with which it is extracted with a thin, long-pointed pick. Its fissile nature probably is due to disturbance at the time the lead was formed. Thin leads have been known to taper out, and what may be called their continuation to start in the side slate, and expand to the original thickness from beyond the termination of the quartz at first worked. While many of the gold-bearing leads are regular and persistent for hundreds of feet, and lie parallel with wonderful uniformity, a careful following shows local troubles. Breaks and dislocations of the strata are not uncommon; and while many undoubtedly are of later age, some appear to be contemporaneous.

The distinctive features of the gold-leads of Nova Scotia, according to Poole, are their general conformability with the slate and quartzite beds, and their regularity, suggesting that they are rather beds than veins. But there are characters that point to their being true veins in spite of these features, and they are the following. The roughness of the planes of contact between quartz and slate and quartzite; the crushed state of the slate or gouge on some foot-walls; the irregularity of their mineral contents; the terminations of the leads; the effects of contemporary dislocations, and the influence of stringers and off-shoots on the richness of the leads: characters that, singly or collectively, it would be difficult to account for, associated with a stratified deposit.

The experience of all the miners, both native and from Australia and the Western States, is united in calling the lodes true veins.

The presence of gold in a Lower Carboniferous conglomerate at Gay's River, would show that some of the veins of Nova Scotia at least are of pre-Carboniferous age. On the other hand, there is no reason why other veins in the province may not be even of Tertiary date, or immediately preceding the formation of the auriferous alluvions.

Alluvial gold-mining has not been carried on in Nova Scotia in any degree commensurate with the value of the auriferous deposits which are in a greater or less degree known to exist, and which, in all probability, occur to a much larger extent than is generally supposed. An impression has arisen that the greater part of the gold-districts present nothing but rocky, denuded areas, without any, or at least very small, drift deposits. The contrary is the case in some districts; and numerous wide-spread surfaces exist where alluvial gold-mining cannot fail to be pursued with great profit, if sufficient capital is embarked in the enterprise.

Drift deposits are found at Waverley, upwards of 50 ft. deep; and at Tangier similar deposits exist, which have already yielded remarkable returns, and have been abandoned on account of want of means to cope with the influx of water. Where rich gold-bearing lodes are exposed near the surface, in the valleys adjacent to such exposures, or in crevices in the rocky surfaces, the gold from the denuded lodes must have accumulated by its gravity. It has been alleged that the greater part of the former auriferous drift of Nova Scotia has been carried by recent denuding action into the Atlantic, and now forms the submarine banks of the coast. This has certainly no foundation, and Selwyn confidently asserts that bare rock surfaces are not more prevalent in the gold-districts of Nova Scotia than they are in similar districts in Australia. In the latter country, the gold-bearing veins are invariably accompanied by rich alluvial deposits; while in Nova Scotia the detrital deposits which certainly occur under precisely similar conditions, are almost invariably said to be unproductive. Perhaps the gold has not yet been sought for with sufficient intelligence and perseverance. Tangier, Oldham, Sherbrooke, Waverley, Renfrew, and many other places, present all the conditions for alluvial diggings, both in the form of old channels and their re-worked condition.

The chief auriferous districts of Nova Scotia are as follow :—

Caribou.—This district is situated 6 miles south of the Musquodoboit River, at Hamilton's Corner, about 36 miles from the Shubenacadie Station. Work of a preparatory character was undertaken first in 1867, and has been carried on in an intermittent manner ever since. Several of the lodes have paid well, as the North, Flat, Cross, and Hyde lodes; of which the Cross lode, at one time, gave quartz carrying 20 oz. A lode on the Bushing area was found to lie for some distance in a horizontal position, apparently in the summit of an anticlinal. In 1877, a lode found on area 629, block 2, 1 ft. thick, yielded, in 6 months, 1170 oz., and from a stope of 40 ft. and within a depth of 120 ft., the shoot of rich quartz being vertical, and at the junction of a cross-lode.

Moose River.—The district lies about 7 miles west of Caribou, and is accessible by road from Middle Musquodoboit; it has only recently received attention. The surface is reported to carry gold, but attempts to wash it proved unsuccessful, it is reported, from improper construction of the flume. Several promising lodes and many rich boulders have been found; and it is stated that, in Dec., 1879, a lode was discovered yielding over 2 oz. to the ton.

Fifteen Mile Stream.—This district lies on a tributary of the East River of Sheet Harbour, about 19 miles from the head of navigation. It is very inaccessible, there being no carriage-road to it. Explorations have been carried on here for several years, and have shown the presence of a large number of promising lodes; and two crushers were built. Its isolation, and the expense of getting supplies, have retarded the opening of this district; it is, however, again receiving attention.

Gay's River.—This district is an interesting one, although it has never occupied an important position as far as its yield of gold is concerned. It is situated about 6 miles east of Shubenacadie Station, on a tributary of Gay's River. Here the gold slates are overlaid by flat beds of Carboniferous conglomerate, an ancient consolidated drift. The gold occurs in grains and scales at the base of the conglomerate, and in backs in the slates; small auriferous lodes have also been observed in the slates. The modern drift overlying the conglomerate has also yielded gold, derived from a similar source, or from the natural working over of the conglomerate. The mining has been done by levels, driven in the conglomerate at the junction of the two formations; but no rule has yet been observed indicating the position of the gold.

Lawrencetown.—This district lies about 12 miles east of Halifax Harbour. In the early days of mining here, a considerable quantity of gold was taken from rich boulders and washings. The chief vein on the Werner property was 8 in. thick, of bluish quartz, showing gold, blende and mispickel. The Capel Townsend property embraces several groups of gold-bearing veins; that known as the Waddilow group includes 13. The quartz, generally enclosed in slates, is somewhat ferruginous, and contains copper pyrites, blende, and a little galena. Some of these lodes are reported to have yielded well. Operations, however, have been almost totally suspended, after large sums have been spent in preparatory work, mills, and machinery. The mining that has been done of late years has been confined chiefly to Crookes' lode, the first opened; and it yielded well at the junction of cross-veins.

A large number of promising lodes are known here, and there is no reason why they should not be worked profitably.

Montague.—This district lies about 6 miles east of Dartmouth, near Lake Loon, and has maintained an average output for a number of years, greatly increased during 1870 and the three following years. The best known lodes are, perhaps, the Belt, Werner, St. Patrick, and Cross veins.

The Belt lode has been worked by several parties, and notably by the Messrs. Lawson, who, in the 5 years ending with 1874, extracted about 10,000 oz., with a handsome profit. The lode is enclosed in slate, separating it from quartzite, and varies in thickness from 4 to 20 in. The quartz is highly crystalline, and shows, besides gold, iron and copper pyrites, and mispickel. The sulphurets, according to Prof. Silliman, are most abundant near the underlying slate, which also holds gold and mispickel in lumps, sometimes weighing 50 lb.

The richest part of the lode at the surface was at the Main shaft; in depth it trended to the westward. For many years, the presence of rich boulders in the surface cover of the eastern part of the district, caused the expenditure of much time and money in a search for the parent lode. In the spring of 1879, G. Stuart and his associates found the vein, called, from the colour of the quartz, the Rose lode. It varies in thickness from 4 to 18 in.; as yet the workings on it are limited, but enough has been done to show a very rich chimney, dipping westward, at an angle of 30°.

Up to the present date (1880), 292 tons have been crushed, yielding 1086 oz. During the past year, a lode close to the Symonds Mill yielded well at the junction of numerous cross-veins, and promises to become more valuable than even the Rose lode.

Waverley.—This district lies about 3 miles E. of Windsor Junction Station, on the Intercolonial Railway. It was reported on by Prof. Hind in 1869. In 1865, the returns gave a produce of 14,000 oz.; but the annual output has since dwindled away to a few hundred ounces. Among the chief lodes that have been worked may be mentioned the Tudor, Brodie, South, and Taylor veins. Large and extensive works were carried on, but they gradually ceased, as the main leads became impoverished in depth, and varying from 150 to 400 ft. Some of the new veins have yielded fairly, as the United, American Hill, New South, and No. 6 lode. The barrel quartz, in the eastern part of the field, attracted much curiosity at one time. Here the lodes follow the strata, as they bend over in an anticline. The corrugations generally have the form of wave-like undulations, rarely that of tight folds; and at one place, a little to the westward, one of the lodes presents a nearly horizontal sheet. The quartz is somewhat banded, and holds calcite, apparently of later date, filling fissures in the lode. This has been worked at intervals for a number of years, and is said to have averaged 12 dwt. per ton.

Oldham. — This gold-field is situated 3 miles east of Enfield Station. Gold was discovered here in 1861, and since that date operations have been carried on, with occasional periods of depression. The worked portion of the district is characterized by a valley, having a nearly east and west course, occupying the crown of a very sharp anticlinal fold, the axis of which is nearly parallel to the area lines. From records obtained by Prof. Hind, it appears that in this district the pay-streak dips east, generally at a low angle.

Among the most noticeable lodes, are the Barrel, Ohio, Frankfort, Ritchie, Hall, Britannia, &c. A large amount of gold was extracted in 1877 from a lode on the eastern turn of the measures, the result of 5 months' work being 1280 oz. On areas 101 to 105, the Blackie lode was worked for some time in search of the mispickel nodules, which were found to carry gold up to 5 and 7 oz. per ton. Mention has already been made of the "angling lodes," of which interesting examples occur here. The low angle of dip of the pay-streak has probably been the cause of the comparatively shallow character of the workings carried on, which proves an impediment to systematic mining. This is to be regretted, as preliminary labours in common would have facilitated operations, and the district promises to be one of unusual richness.

Renfrew.—This district lies about 7 miles west of Enfield Station, near the north end of Grand Lake. Work was begun here about the same time as at Oldham, and the returns show a steady increase to 7904 oz. in 1867; and a decrease to but 3 oz. in 1874; since that date there has been a slight improvement. Among the more prominent lodes, may be named the Preeper, Sims, North, South, and Brook. The operations of the Ophir Company were systematically conducted for several years, and handsome profits realized; but the workings were abandoned at a depth of 350 ft. Their returns during 5 years were 17,532 oz. 13 dwt. 21 gr. from 21,012 tons of quartz. All the mining has hitherto been confined to the south side of the anticlinal; the measures on the north side are generally covered by soil, and although rich boulders have been found, the parent lodes remain for future workers. The proximity of Lower Carboniferous measures, and their position relative to the lodes, furnish, according to Prof. Hind's report, favourable conditions for the accumulation of alluvial gold.

Sherbrooke.—This district lies about 38 miles by stage from Antigonish, on the Halifax and Cape Breton Railway, near the village of Sherbrooke, on the St. Mary River, and ranks first in the list of Nova Scotia gold-fields. Up to September, 1866, it produced 19,101 oz., at the rate of 1 oz. 16 dwt. to the ton. In the following year, 5809 tons yielded 8522 oz. of gold. The lodes and associated rocks present no features distinguishing them from those of other localities.

Among the numerous operations, the Wellington may be mentioned. Here work has been carried on ever since the discovery of gold in the district. The Wellington, Dewar, and other veins have been mined to depths varying from 400 to 600 ft. The proprietors have conducted their operations with care and prudence, and received a good return. Between the years 1863 and 1869, they extracted 8984 tons, which yielded 12,215 oz., and similar results have since been obtained. On the adjoining Grapevine properties, favourable results have been made for a number of years. Other properties that have paid well during the past year are the Dominion and the Wentworth. A very large amount of work has been done by other parties in this district, and it appears, from the continual discovery of workable lodes, likely to afford equally encouraging results for a long time to come. At Cochran's Hill, a little has been done in lodes running in slate belts, and also at the Crow's Nest, 2 miles to the westward. The strata here are highly metamorphosed. The yield per ton has been low—4 to 8 dwt.; but the cheapness of extraction has enabled work to be carried on at a profit.

Stormont.—This district, also known as Isaac's Harbour, lies east of Sherbrooke. For several years the returns gave an annual yield of about 1400 oz.; but, during the last few years, the mines have remained almost entirely neglected. Promising lodes have been found in the surrounding country, but have not yet been thoroughly tested. No district has better promise for the future. The extent of mining that was carried on is very small, and limited to a few lodes. The Mulgrave yielded, from two areas, in 1863–4, 621 tons of quartz, giving 1897 oz. of gold; and the work done since has frequently yielded equally well.

Wine Harbour.—This district lies on the coast, about 4 miles E. of the mouth of St. Mary's River, and 12 miles from Sherbrooke. Here the auriferous quartz lodes are met with, over a belt nearly a mile from N. to S., and are in thick bedded quartzites, generally associated with thin layers of finely-laminated, bluish slate, which facilitates mining. The returns show a falling off from the best year, 1864, when 4033 oz. were obtained. Work has been confined chiefly to the ground owned by the Eldorado Company. The property of the Provincial Company has frequently yielded good quartz, the Caledonia Company having mined in 6 months $200,000 (40,000*l.*) of gold. The Hattie lode has also yielded well.

Tangier.—This district lies on the Atlantic shore, about 50 miles east of Halifax, and is well known as the earliest opened. In the eastern part of the district, at Strawberry Hill, work has been pursued for a number of years, chiefly on lodes known as Dunbrack and Forrest, and others associated. The strata and the lodes are cut by a granitoid (?) dyke, about 15 ft. wide, which can be traced for several miles in a south-west direction. It does not appear to affect the contents of the lodes in any way, nor to have shifted them.

A number of lodes extending to the Tangier River have been worked at various times; among them may be mentioned the Field, Leary, Nigger, &c., which have yielded fair returns in the moderate depth they have been worked to. A considerable quantity of gold was found in the alluvion at one place in this district, and a pond called Copper Lake was partially drained: Prof. Silliman states that a layer of tough clay and glacial drift was met with underneath the mud and vegetable matter, and everywhere in the under-clay small round nuggets were found. The work of washing was, however, abandoned, as the drainage was not carried deep enough to allow its proper application.

Mount Uniacke.—This gold-field lies about 3 miles from Mount Uniacke Station, on the Windsor Railway. A large number of lodes have been exposed over an area having a breadth of about 1½ miles, and a length of 6 miles. The veins are similar to those of other districts, and enclosed in quartzite, frequently with linings of slate. Their thickness varies from one inch to several feet, and the large veins are sometimes divided into layers by interlaminations of slate.

The crystalline quartz, sometimes milky-white, sometimes bluish, the latter being often laminated, fills the greater part of the lodes, and generally the widest; while arsenical iron-pyrites, or mispickel, is, at the outcrop, the mineral of the narrower lodes. Certain quartz lodes appear to the sight almost entirely destitute of foreign matter, while others contain metallic sulphides, such as cubic iron-pyrites (often decomposed), mispickel, and sometimes blende, galena, and copper-pyrites. Hind observed in all the selvages of some lodes, a blackish earthy substance which appeared to be oxide of manganese.

Great irregularity of formation and structure characterizes the lodes generally. Lodes, hardly impregnated with arsenical iron-pyrites at the outcrop, on narrowing in depth, become converted into veinlets of pure mispickel. Such lodes, measuring several inches at their outcrop, are reduced to a mere thread at a few feet in depth, while others are subject to successive and sudden contractions and swellings. But the most extraordinary case of irregularity, is that of the lodes which assume curiously twisted shapes by branching sometimes to the north, sometimes to the south. The constancy of formation and structure, that is to say, the regularity of the deposits, has been, so far, the rarest case with the lodes in these areas; but experience has demonstrated in many localities, that the disorders described often disappear at a certain depth.

Other Districts.—Among other districts, may be mentioned the Ovens in Lunenburg County, where alluvial washings were carried on for a short time; Gold River, Yarmouth, Stewiacke, Chezzetcook, Ship Harbour, Harrigan Cove, Moose Head, Ecum Secum, &c. Gold has also been reported from the Cobequid and South Mountains. In Cape Breton, the Middle River, Baddeck, was some years ago made a gold-district, under the name of Wagamatcook; but no profitable lodes have been found, although the slates occasionally yield scales of gold, and it occurs everywhere in the beds of the streams Campbell reported, in 1863, his examination of the northern part of Cape Breton, and the discovery of alluvial gold in the sands of many of the brooks.

In Nova Scotia, the dip varies from east to west, and each district has its own experience to guide the miners. It is to be regretted that no records or plans have been kept. The streaks are found to vary in width, and sometimes to be lenticular, and to die out before coming to the surface. It thus happens that frequently the miner finds himself confronted by barren quartz, becomes discouraged, and abandons his work, when prospecting tunnels might have disclosed another streak at no great distance. On this subject, Dr. Sterry Hunt remarks that to abandon a working on account of a momentary impoverishment of the lode is too often done in this region; and that in a large enterprise, where mining is carried on in several veins at a time, the richness of some may always be counted upon to compensate for the temporary poverty of others. He has stated his opinion that many of the workings now (1866) abandoned as unprofitable, will be again taken up with advantage.

This leads to the consideration of permanence in depth of the gold yield; in some districts, it is considered that no gold will be found in paying quantity beyond a certain depth. This probably is a case of a pay-streak lying in a comparatively horizontal position, and having an unproved interval of barren quartz below it. Gilpin thinks it will be found that there need be no apprehension of the extinction of the veins in depth being reached at distances less than those through which they are known, from surface evidence, to extend horizontally in directions parallel and transverse to the anticlinal axes; and that, as these distances are reckoned by thousands of feet, it may very safely be conjectured that there is practically no limit to the depth to which the lodes may be successfully followed.

The quartz is sorted and broken by hand for the stamps. The mills are of the common pattern, with revolving stamps, weighing generally 550 to 700 lb.; though a few run with 450-lb. stamps, working in cast-iron boxes. The batteries are provided with tables, and in some cases with secondary oscillating plates, or tail runs, with or without ripples. The use of plates in the batteries is not in practice. The system of battery amalgamation is universally adopted; the use of blankets is unknown, and no attempts, beyond an occasional settling-tub, are made to catch any lost amalgam, &c. These methods answer tolerably well for much of the Nova Scotia gold, which is present in a coarse, free form, but prove inadequate to treat fine gold and that held in the pyrites. No regular system of assaying tailings and pyrites has ever been carried out, but the tests made show what "a shameful waste has gone on since gold-mining began." (Gilpin).

In support of this, the same authority quotes numerous official analyses, one of which showed the presence of nearly 15 dwt. of gold to the ton of tailings, not over 8 dwt. having been saved in the original working. The average amount of gold in the tailings from Nova Scotia mills may, according to Prof. Hind and others, be averaged at 4 dwt. to the ton. The mean yield of two samples of tailings from Montague quartz, crushed at Waverley, gave Prof. Silliman 16 dwt. 13 gr. of gold per ton. It has been stated that at least 20 per cent. of the gold originally present in the lodes, is allowed to pass through the mills, and to escape to the nearest brook or pond, some mill-owners boasting of their facilities for getting rid of the tailings.

Nova Scotia gold, like that of other countries, is an alloy in which silver forms the chief of the impurities. The average fineness is 955 in 1000. The following analyses will show its character:—

Locality.	Authority.	Gold.	Silver.	Iron.	Copper.	Lead.	Zinc.	Total.
Old Tangier	O. C. Marsh ..	98·13	1·76	trace	0·05	..	..	99·94
Tangier (Field Lode)	B. Silliman ..	97·25	2·75	..	..	..	..	100·00
„ (Leary Lode)	U.S. Assay Office	96·60	..	..	..	..	..	..
Waverley (Laidlaw's)	H. How	94·69	4·74	..	0·39		0·16	99·98
O	A. Gesner ..	93·06	6·60	..	0·09	..	..	99·75

YEARLY GOLD YIELD OF NOVA SCOTIA.

Year.	Total Gold extracted.			Stuff crushed.	Yield per ton of 2000 lb.			Total days' labour.	Average earnings per man per day and year, at 300 working days, $18 per oz.	
									A Day.	A Year.
	oz.	dwt.	gr.	tons.	oz.	dwt.	gr.		$ c.	$
1862	7,275	0	0	6,473	1	2	11	156,000	0 83	249
1863	14,001	14	17	17,002	0	16	11	273,624	0 92	276
1864	20,022	18	13	21,434	0	18	16	252,720	1 42	426
1865	25,454	4	8	24,423	1	0	20	212,966	2 15	645
1866	25,204	13	2	32,161	0	15	2	211,796	2 14	642
1867	27,314	11	11	31,386	0	17	9	218,894	2 24	672
1868	20,541	6	10	32,262	0	12	17	241,462	1 53	459
1869	17,868	0	19	35,147	0	10	4	210,938	1 52	456
1870	19,866	5	5	30,829	0	12	21	173,680	2 05	615
1871	19,227	7	4	30,791	0	12	11	162,994	2 12	636
1872	13,094	17	6	17,093	0	15	7	112,476	2 09	627
1873	11,852	7	19	17,708	0	13	9	93,470	2 28	684
1874	9,140	13	9	13,844	0	13	5	77,246	2 12	636
1875	11,208	14	19	14,810	0	15	4	91,698	2 20	660
1876	12,038	13	18	15,490	0	15	13	111,304	1 94	582
1877	16,882	6	1	17,369	0	19	10	123,565	2 46	738
1878	12,577	1	22	17,990	0	13	23	110,422	2 05	615
1879	13,801	8	10	15,936	0	17	8	92,002	2 34	732
1880	13,234	0	4	14,037	0	18	20	103,826	2 18	654
Total	310,606	5	5	406,185				3,031,083		

The following table exhibits a general statement of the condition of the Nova Scotia gold-mining industry in the year 1880:—

GENERAL STATEMENT OF THE CONDITION OF THE NOVA SCOTIA GOLD-MINING INDUSTRY IN THE YEAR 1880.

DISTRICTS.	Number of Mines.	Days' Labour.	Mills employed.	Steam Power.	Water Power.	Quartz, &c., crushed.	Yield per Ton.			Maximum Yield per Ton.			Total Yield of Gold.			Average yield per man per day for 12 months at $18 (75s.) per oz.
							oz.	dwt.	gr.	oz.	dwt.	gr.	oz.	dwt.	gr.	$ c.
Caribou	3	5,418	3	3	..	824	1	0	0	3	12	16	823	5	19	2 55
Gay's River ..	1	189	1	..	1	40	0	8	15	0	4	6	13	6	6	1 24
Montague	5	22,144	2	2	..	1,221	3	9	22	9	13	0	4 270	8	17	3 47
Oldham	2	2,205	2	1	1	1,475	0	11	5	7	3	14	829	4	17	6 75
Renfrew	1	796	1	..	1	537	0	5	19	4	5	0	155	14	13	3 50
Sherbrooke ..	12	36,240	7	4	3	6,465	0	12	12	5	10	0	4,042	7	9	2 07
Stormont	1	3,261	..	..	..	175	1	19	7	2	1	20	346	12	0	1 91
Tangier	3	13,343	3	1	2	790	0	13	10	2	13	8	530	14	3	0 70
Uniacke	4	10,316	3	2	1	1,505	0	15	10	3	3	11	1,161	16	12	2 02
Waverley	2	3,274	3	1	2	346	0	9	1	3	2	12	156	13	15	0 85
Wine Harbour ..	1	1,262	2	1	1	161	0	7	10	3	0	0	61	12	0	0 87
Unproclaimed ..	3	5,378	5	1	4	498	1	13	10	3	2	9	842	4	13	2 81
	38	103,826	32	16	16	14,037	0	18	20	9	13	0	13,234	0	4	2 81

COSTA RICA.—According to Keith Johnston (1877), the principal gold-mines are 3 in number:—(1) Those of Trinidad, 4 "leagues" inland from Punta Arenas, 1200 ft. above the sea, worked on a small scale by a native company, and extracting 17½-carat gold from quartz; (2) Those of the Cerro del Aguacate, one of which is worked by the local Compania de la Montaña del Aguacate, and in an imperfect yet profitable manner; (3) That called Sacra Familia, lying a little north of the Aguacate mines, at an altitude of 3000 ft. one of whose veins consists of auriferous quartz similar to that of Trinidad, and is worked on a small scale by private individuals, giving gold of 15½ carats. Gold is also said to exist in the wild Indian country of the Atlantic slope.

In 1852, there was a small mint in Costa Rica, which coined $50,000 to $100,000 (10,000*l.* to 20,000*l.*) yearly, chiefly in dollar gold pieces.

The name of Costa Rica, or "rich coast," says Bates, was given to the country by the Spaniards, not on account of the wealth actually found there, but of the wealth they hoped to find there. Nor was it till some time after the discovery of the gold-mines of Aguacate, in 1823, that the resources of the land began to be developed. Since then, its mineral wealth has been continually increasing in importance, and attracting the foreign capital needed to open up the mining districts. This was especially the case when the gold-mines of Paires were found in 1857, followed by the discovery of the still more productive mines of Cirueletas in 1864. Costa Rica may, in his opinion, be considered the richest of the five Central American States.

In 1873-4, W. M. Gabb was employed by the Costa Rica Government in exploring the south-eastern corner of that country, a region of about 3000 square miles, known as the district of Talamanca. His object was to re-discover some mines of fabulous richness supposed to exist; but he declares that "such mines do not, and for sufficient geological reasons cannot, exist there." His instructions required him to look for mines, and he examined carefully for traces of the precious metals wherever he went. He found in a few places quartz veins: one of considerable size, the others practically valueless. Also deposits of placer-gold in a few localities. But "the existence of gold here is rather of scientific than of economic interest." The gold occurs in the metamorphosed Miocene rocks, and always at a greater or less distance from the granites. The point at which he found gold nearest to the granite was at least a mile distant, although the rock was highly metamorphosed. The spot where he found the largest quantity of gold was miles away from granite.

On the western face of the Aguacate Mountain, are found highly altered claystones. These are rich in mineral veins, and have been thoroughly explored for mines of gold and silver.

Some notes culled from the prospectus of the Costa Rica Company

(1830) are worth recording here. The particular mines to which the views of the Company were directed, are those of Quebrada-Honda and Machuca, situated in the mountainous region of Aguacate. They are about 14 leagues (Johnston says 4) distant from the port of Punta Arenas, in the gulf of Nicoya. These mines were first discovered in 1822, and have been worked both for gold and silver—the former, even from the surface, being an object of such importance as to pay for extracting it by a separate operation. The latter is likewise productive from the surface, but increases rapidly in quantity towards water-level and beneath; and at the greatest depths to which the natives have reached, the gold has been found (as to value) in at least an equal proportion with the silver. The ores near the surface yield on an average about 2 oz. of gold per ton, and from 5 to 10 *marcs* (2½ to 5 lb.) of silver. Between the top of the water-level and a point 15 ft. lower (beyond which the natives, through the want of mechanical skill, have not been able to penetrate), the ores have given at different depths from 90 to 200 oz. of silver to the ton; and every pound troy of the silver has been found to contain 15 dwt. 12 gr. of fine gold—being equal in value (per ton of ore) to 102 oz. of silver.

A Consular Report for 1880 states that Costa Rica mining will always be restricted for want of capital, skilled labour, and good machinery. The gold-mines called La Union, near to Punta Arenas, have been recently sold to a French Company for 20,000*l.*, which company will provide the necessary machinery, and in time, will probably make them remunerative. At present there are a few other mines worked by private capitalists, but with no great success.

Wagner and Scherzer (1857) allude to the quartz vein at Aguacate as being opened in 1822, and having given considerable profit. An assay of the ore showed 66 per cent. of gold, 33½ of silver, and ½ of copper. José Joaquin Mora, brother of the President of the Republic, who owned the property, told the visitors that the average gold yield of the ore was 25 per cent. of the precious metal, and that at the commencement of the works, 200 lb. of mineral gave 110 oz. of gold.

Hale (reviewed in Bull. Soc. Geog. vol. viii. pp. 99-111; Paris: 1827) says that the whole of Costa Rica is full of mines of gold; the Indians collect much gold on the banks of the lagoons of Chiriqui; more than 50 mines are already in work.

GUATEMALA.—Before 1820, whatever of gold and silver had been collected in Guatemala, was included in the returns from Mexico, according to Jacob. The figures given by Thompson are 146 *marcs* (of ½ lb.) in 1823, 526 in 1824, and 253 in the first half of 1825. The export in 1878 is officially given as $15 (3*l.*) in value, to England. In 1878, an

American mining engineer was employed by President Barrios to make a complete survey of the gold-district discovered three years before. He reported the ground along the banks of the Motagua River, and for a considerable distance into the interior, to contain much gold, though no quartz has yet been found.

HONDURAS.—Bates says that the rivers on the slopes of the Sulaco range, which rise nearly in the centre of the State, wash down gold. Dunlop observes that the ores generally contain 1 to 1½ per cent. of gold, which is also obtained in the river deposits by the Indians, pieces weighing 5 or 6 lb. having occasionally been discovered. The gold-washings, if not the gold-mines proper, according to Squier, are most numerous on the Atlantic slope; "the principal supply of gold is from the washings of Olancho, which are exceedingly productive." At Moran bar, on the river Guayape, river washing is said to be carried on, the prospects all over the bar being 8c. to 12c. (4*d.* to 6*d.*) per pan. The water is 4 ft. deep, with a considerable current in the dry season; during the wet season of 6 months, work is suspended.

According to Bancroft, the art of extracting and melting gold has long been known to the Mosquitos in Honduras; but, although they wear a few ornaments of this metal, they do not seem to prize it very highly. At the time of Cockburn's visit to Honduras, dams were used in mining, and instruments of cane to sift the gold. The mode employed by the Poyas to separate gold from sand, is the one known in California as panning, and is thus described. Scooping up some of the sand in his bowl, and then filling it with water, the Indian whirls it rapidly, so that a feathery stream of mingled sand and water flies constantly over its edge. He continues this operation until the sand is nearly exhausted, and then fills the bowl again. After repeating this process several times, he grows more careful, balancing the bowl skilfully, and stopping occasionally to pick out the pebbles. When the process is complete, a little deposit of gold, in grains, lies at the bottom of the calabash. The gold-dust passes into the hands of the white trader.

The date when the mines of Yuscaran (a town distant about 1 day from the borders of Nicaragua) were first opened, says Scherzer, is not on record: many of them appear to have been worked for centuries. Five are now (1857) systematically worked. The Malacate mine, the oldest in Yuscaran, and which 30 years back was the most productive of the auriferous silver-mines of the state, was, about 7 years ago, taken by a company, who expended great sums in clearing away the rubbish by which the galleries were choked, in order to get to the principal vein. But after 7 years of continued digging—after penetrating 450 ft. in a perpendicular, and 1800 ft. in a horizontal direction, the point has not yet been reached where the former miners left off working. Another of the silver-mines here, the Sanctissimo Sacramento, is worthy of mention. The third mine in the neighbourhood of Yuscaran that he visited, was that of Montserate. The ore is found here, as in all the mines of Yuscaran, in combination with quartz, felspar, and Black Jack; 2500 lb. of rock gave $55 (11*l.*) worth of silver, $5 (1*l.*) of gold, and cost $20 or $22 (4*l.* to 4*l.* 8*s.*) in workmen's wages. On an average, about 10 tons of ore are got out of the mine here every week; but a large portion of it is still lying under water.

It is recorded in a Consular Report (1861) that, properly speaking, few gold-mines in Honduras are as yet discovered; but gold occurs abundantly in some of the rich silver-mines, in many of which, in fact, the silver is found in combination with gold, iron, lead, zinc, antimony, mercury, sulphur, etc. Most of these mines are situated along the chains of mountains which lie on the Pacific slope, while gold-dust and some gold-mines are to be found on the Atlantic side. Gold, according to all accounts, is found in great quantity, and of the best description, in the beds of all the rivers which flow into the Atlantic, and the washings in these placers are represented to be highly remunerative. Men and women employ themselves during certain portions of the year in gold-washing, and they sell the gold-dust at from $11 50c. to $12 (48*s.* to 50*s.*) the oz. By far the greatest quantity of the gold exported from Honduras is raised in this way, from the rivers Guayape, Jalan, and Manguile, in the department of Olancho, where it is found of the purest quality, as likewise in those of Yaguale, Sulaco, Pacaya, and Caimito rapids in Yoco. Minas de Oro, a village in the northern part of the Department of Comayagua is, as its name implies, situated in a particularly auriferous district, the precious metal being found not only in veins of a very rich character, but also in beds and fragmentary deposits along a number of streamlets and small rapids flowing into the Sulaco river. In this district are situated the copper-mines which furnish all the metal used for the mintage of the "provisional" currency, and gold is here also found to exist in a considerable proportion, as has been proved by washing the dust obtained in the process of bruising the copper ores.

The most recent information concerning British Honduras gold-deposits is furnished by Colonial Secretary Henry Fowler. The Machaquila, a rapid stream, was "full of the best gold prospects" the exploring party saw; and in the neighbourhood of the Belize and Machaquila rivers, fair specimens of auriferous quartz were found. At one place was encountered a quartz reef projecting 20 ft. above the ridge (3100 ft.), and 10 to 12 ft. wide, running through a sandstone formation in a direction N.E. and S.W.; it was full of iron pyrites, which revealed gold on analysis. Traces of gold and silver have been discovered in Deep River, 30 miles from its mouth.

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The mineral district explored by Fowler's party is a belt of country 20 or 30 miles broad, running N.E. and S.W. from the south of the Cockscomb Range into the neighbouring republics of Guatemala and Honduras, and parallel to and distant from the coast as the crow flies about 25 miles. The quantity of gold produced from the Honduras mines has increased considerably of late, and it has become a means of remittance by the Belize merchants. Fowler ascertained that 1756 oz. were shipped from Belize, "under the past 6 months (1879), which have been obtained immediately south of us. This represents the smallest portion of the entire product." He saw nuggets from Honduras weighing over 3 oz.

MEXICO.—Jacob remarks that up to the invasion of Mexico, gold alone has been found in America, or, if any silver had been procured, it must have been in such small quantities as not to deserve mention. Cortez, in his advance towards the capital, received 2560 *marcs* of gold (nearly 70,000*l.*) at Chalco; and subsequently 100,000 ducats (each equal to about $2 39c., or 9*s.* 7*d.*) from Montezuma. The mineral wealth of Mexico is proverbial, but consists more of silver than of gold, though the latter is very abundant.

The most extensive account of the gold-mines of Mexico is given by Ward (1828). According to him, the gold contained in the silver (a great abundance of which is found in the ores of some mines) was never properly separated from it, after the communication between the interior and the capital was closed. None of the Departments possessed a Casa del Apartado (in which the chemical process of separating the two metals, when combined, is performed); and although some portion of the gold may nave been obtained by the use of quicksilver in the *arrastres* (crushing mills), whatever remained incorporated with the silver was sacrificed. As the amount of gold produced annually before the Revolution averaged $1,100,000 (220,000*l.*), a great part of which passed through the Casa del Apartado, this loss in 15 years must have amounted to a very considerable sum. Ward himself saw ores from Guarisamey, at the mint of Durango, which contained 2100 gr. of gold to the *marc* (5760 gr. = 1 lb.). The mines of Rayas have produced ores containing 2700 gr.; and 550 gr. per *marc* (½ lb.) is by no means an uncommon *ley de oro* (proportion of gold) in the mine of Villalpando, at Guanajuato. These observations sufficiently prove the unavoidable inaccuracy of any estimate that can now be formed, respecting the amount of the precious metals raised from the mines of Mexico during the 15 years immediately subsequent to the Revolution. The following three tables are given by Ward, the *marc* of silver being taken at $8½ (35*s.* 5*d.*), and that of gold at $136 (28*l.* 6*s.* 4*d.*):—

ACCOUNT OF THE COINAGE OF THE MINT OF MEXICO.

Year.	$	Year.	$
1796	1,297,794	1811	1,085,364
1797	1,038,856	1812	381,646
1798	999,608	1813	..
1799	957,094	1814	618,069
1800	787,164	1815	486,464
1801	610,398	1816	960,393
1802	839,122	1817	854,942
1803	646,050	1818	533,921
1804	959,030	1819	539,377
1805	1,359,814	1820	509,076
1806	1,352,348	1821	303,504
1807	1,512,266	1822	214,128
1808	1,182,516	1823	291,408
1809	1,464,818	1824	236,944
1810	1,095,504	1825	2,385,455
Total	16,102,382	Total	9,400,691

PRODUCE OF GUANAJUATO, 1796–1825.

Year.	Marcs of Gold.	Year.	Marcs of Gold.		
1796	1,081	1811	550	0	0
1797	968	1812	907	0	0
1798	2,529	1813	462	0	0
1799	1,972	1814	708	0	0
1800	1,932	1815	841	0	0
1801	1,457	1816	694	0	0
1802	1,676	1817	523	0	0
1803	1,538	1818	401	0	0
1804	2,128	1819	450	2	2
1805	2,495	1820	326	2	7
1806	2,188	1821	298	3	6
1807	2,396	1822	597	2	2
1808	1,842	1823	413	5	5
1809	2,189	1824	517	3	6
1810	1,419	1825	419	4	0
Total	27,810	Total	8,109	0	4

The mines of Tlalpujahua are situated in N. lat. 19° 17′ 30″, and W. long. 100° 1′ 15″, upon the slopes of the mountains by which the valley of Tlalpujahua is formed. Their position is extremely favourable for drainage by adits; and the shafts are neither difficult of access, nor at an inconvenient distance from the town, most of them being contained in a circle of 2 English miles. The metalliferous veins of this district are found principally in the phyllade (thonschiefer or clay-slate), which contains in subordinate strata, (1) grauwacke, (2) grauwacke slate, (3) transition limestone, (4) talkschiefer, (5) prismatic felspar of Jameson, (6) diabase (principally composed of prismatic felspar and straight-edged augite of Jameson), (7) quartz. The veins of Laborda and Coronas vary in dimensions from 16⅓ to 5½, and 8¼ English ft.; that of

Las Virgines attains in some parts a width of 27½ and even 33 ft.; nor has any falling off been observed at the greatest depth to which these veins have yet been explored. The ores contain native gold (hexahedral gold of Jameson) and native silver (hexahedral silver), which are found in small quantities. Rhomboidal silver-glance (l'argent antimonié sulfuré noir) is most abundant; and next to it hexahedral silver-glance, or argent sulfuré. The red silver, or argent antimonié sulfuré rouge, is less common but may frequently be found. Tlalpujahua enjoys many advantages as a mining district. It is situated at a moderate distance both from the capital and the coast, in the midst of a very fertile country. Wood is equally abundant and cheap. Mining labour of all kinds is lower than in any of the neighbouring states. Few of the mines exceed 150 *varas* (417 ft.) in depth, and almost all are so situated as to facilitate their drainage by a single adit for a very considerable space below the deepest of their present workings. The ores of some contain a *ley de oro*, so considerable as to raise the value of the *marc* (½ lb.) to $12 and $16 (50*s.* to 66*s.* 8*d.*); and in reducing these ores, the assistance of water power is almost always to be obtained.

The gold-mine of San Jose del Oro, in the mining district of Zimapan, was formerly immensely productive, but has for many years been abandoned and in ruins. The ore is composed of felspar and copper, intermixed with gold, which is found pure in very minute particles, and is separated from the copper in a few hours by the use of quicksilver in the *arrastres*.

The mines of El Oro (Rancho del Oro) are situated just within the confines of the state of Mexico. None of the shafts exceed 155 *varas* (431 ft.) in depth. In August, 1826, El Rosario was the only shaft from which ore was raised. The vein appeared to be rich, but small. The gold is found in particles, imperceptible to the naked eye, in a matrix of quartz, which contains sulphuret of silver disseminated throughout the mass in narrow stripes. Gold-mines in Mexico generally diminish in value as they increase in depth, and Ward apprehends that the district of El Oro will not form an exception to this rule. The mines, however, were worked to advantage as late as 1810, and it is upon record that, in 1805, a single *carga* of ore was sold at the mouth of the shaft for $11,000 (2200*l.*). [It is difficult to estimate the measure or weight of the *carga*. Ward makes it 3 *quintals* or 12 *arrobas*: the former would be equal to 312 lb., the latter to 300 lb. Browne's Handbook states it to be 12 *panegas*, each of 12 *almudas*, which would amount to 18 bushels.]

The mine of Villalpando is situated in the mountains to the east of Guanajuato, about 4 leagues from the town, upon a separate vein, totally unconnected with the Veta Madre. The deepest level does not exceed

200 *varas* (556 ft.). The ores are rich in gold, and in appearance resemble those of the Rancho del Oro: they are often worth $30 to $35 (6*l.* to 7*l.*) per *marc* (½ lb.).

San Juan de Rayas is one of the most valuable mines upon the Veta Madre, or great Mother Vein, of Guanajuato. This Veta Madre is composed of several parallel veins, running N.W. and S.E. Rayas is situated in a ravine immediately below the mines of Santa Anita and San Vincente, which, in accordance with the Mining Code, can only claim to a perpendicular depth of 200 *varas* (556 ft.); all below that depth is free, and belongs to those who can first work it. The extraordinary richness of the ores of Santa Anita, some of which were sold during the great "bonanza" of that mine in 1740 for their weight in silver, in consequence of the large proportion of gold contained in them, first induced Rayas (the proprietor of San Juan de Rayas) to carry his own works below them; this was ultimately done, and exclusive possession of the vein obtained. The first great "bonanza" was obtained through the shaft of Santa Rosa; when this was exhausted, new workings were tried in a S.E. direction, and the shaft of San Miguel was sunk at an expense of $700,000 (140,000*l.*), through which a second "bonanza" was obtained, which yielded a nett profit of $11,000,000 (2,200,000*l.*). From 1760 to 1780, the mine continued to be worked with considerable profit; but in the latter year, a torrent formed suddenly in the mountains, burst into the mine, filled the lower levels, and destroyed nearly all the men. It took 19 years to completely drain the mine of this water; but from 1799 for the next 4 succeeding years, a profit of $400,000 (80,000*l.*) was made annually. Since then, the greatest part of the produce has been absorbed in sinking another enormous shaft; but the Civil War and Declaration of Independence in 1821 had so impoverished the owner that he was compelled to seek assistance of a British company. In November, 1826, the lowest and best levels were still under water, although the company had succeeded in extracting ore to the amount of $75,000 (15,000*l.*) from those which had been drained. Rayas is regarded as one of the richest mines in the world, its ores in the deeper levels being very abundant and rich, some of them containing as much as 2100 gr. of gold in the *marc* (½ lb.); and in the ores called *guija de oro*, native gold is found disseminated in considerable quantities in the quartz.

Since its first discovery in 1556, Rayas appears by the books of the proprietors to have paid to the Provincial Treasury, as the king's fifth, the sum of $17,363,000 (3,472,600*l.*). It has not yet (1828) nearly approached the depth at which the produce of the Veta Madre is supposed by Humboldt to become less valuable; and as, says Ward, "a large tract of virgin ground will be laid open by the Tiro General (the new shaft), it may be considered almost as a new mine, with all the security for its future productiveness that an experience of three centuries can give."

The mines of the Cerro de San Pedro, near San Luis Potosi, have been abandoned for many years on account of the extreme poverty of the ores, which, notwithstanding a *ley de oro* by no means inconsiderable, will not (1828) defray the expense of working: $80,000 (16,000*l.*) were spent in a fruitless attempt to bring them into activity about 10 years ago; but the heaps of old slag that are to be seen at the present day in every direction about San Luis attest their former prolificness, as the epithet of Potosi, bestowed upon the Intendancy, bespeaks the reputation which they at one time enjoyed for wealth.

The State of Durango is rich in mineral deposits, none of which, excepting Guarisamey and San Dimas, have been at all extensively worked. There is hardly a single mine exceeding 100 *varas* (278 ft.) in depth, for in general, the use of even the simplest machinery was unknown in the north of Mexico. The mines were worked as long as the water could be raised without inconvenience by two or three carriers, with leathern buckets, and abandoned when the discharge of this duty became too laborious.

It is from the mines of Guarisamey that the ores most celebrated for their *ley de oro* proceed. The proportion of gold is sometimes so large, that a very small *tejo*, or cake of silver, which Ward saw at the Assay office of the Mint, was valued at $2800 (560*l.*). In the other mining districts of Durango, to the eastward of the Sierra Madre, there is less gold; and in the lead ores of Mapimi and Cuencame, none. About Tamasula, gold is found pure, and it abounds in the whole western declivity of the Cordillera, where native gold, or gold intermixed in very large proportions with the silver, are the characteristics of most of the principal veins.

The chief mining districts of Durango are those of Gavilanes, Guarisamey and San Dimas, Tamasula, Canelas, and Sianori, all of which are situated towards the western boundary of the state, upon the descent from the Sierra Madre to the coast; with Guanasevi, Indee, El Oro, Cuencame, and Mapimi, to the eastward of the Sierra Madre, and differing from those first mentioned, not less in the quality of their ores (which are poor, but extremely abundant, and intermixed with lead), than in their elevation above the level of the sea. Gavilanes, Guarisamey, and San Dimas, lie nearly in the same parallel with the city of Victoria, but about 5 days' journey to the westward,—three spent upon the tableland, and two amidst the fastnesses of the Sierra Madre. The deep and narrow ravines in which Guarisamey is situated are Tierra Caliente, while the mountains that shut them in attain the highest elevation of the Sierra Madre, estimated at 9000 ft. Gavilanes, on the contrary, stands upon a projecting platform, on the side of one of the mountains, not very far from the summit. In this last district, the mines are all opened upon one lode, which in dimensions may almost vie with the Veta Madre of Guanajuato. It was discovered by its elevated crest, and was found to produce very rich ores from the surface to the depth of 60 *varas* (167 ft.), where a kind of black ore was discovered, which resisted all attempts to reduce it to advantage. By smelting, it yielded little or nothing, and by amalgamation, although the quantity of silver produced was very considerable, the loss of quicksilver was so great as to leave no profit. On the other hand, the vein, which at the surface was only 1 *vara* (2·782 ft.) in width, increased gradually until, at the depth of 70 *varas* (194 ft.), it was 10 *varas* (28 ft.), and in some places more than 15 *varas* (42 ft.) wide. An adit was driven, with an intention of piercing the lode 100 *varas* (278 ft.) below the old workings; but from some miscalculation in the measurements, it did not reach the point where it would have cut the vein, and was given up by the proprietors in despair. Since that time, Gavilanes has been upon the decline; and, in 1826, the district only contained one mine in activity, although abounding in metalliferous veins.

Guarisamey, the head of the surrounding districts, owes its discovery to the lode of Tecolota, which crosses the high road from Durango to the coast, by Cosala. The abundance and richness of its ores soon brought settlers into the vicinity of the mines; the neighbouring mountains were explored, and the veins of Arana, Cinco Senores, Bolanos, Piramide, Candelaria, Dolores, and Tapia were discovered, with numberless others, which have not yet been worked, the miners of Guarisamey having never attacked a vein that did not leave a clear profit from the very surface of the earth.

Almost all the lodes mentioned above were "denounced" (a Mexican mining term for obtaining a grant) by Zambrano, and all produced "bonanzas," some of which were considerable. The mine of Arana was remarkable for containing, between two small stripes of rich ore, a cavity filled with a rich metalliferous dust, composed almost entirely of gold and silver. It was likewise distinguished by many of those rich spots, commonly called *clavos*, which, although of small extent in a horizontal direction, were very constant in perpendicular depth. These *clavos* were worked to a depth of 180 *varas* (500 ft.), though the mine had no shaft; and during the whole of this space, the most ordinary ores yielded 10 to 15 *marcs* (5 to 7½ lb.) to the *monton* of 17 *quintals* (1560 lb.), while the richest are said to have produced 70 to 105 *marcs* (35 to 52½ lb.). The lode of Cinco Senores is 5 *varas* (14 ft.) wide, and the quality of the ores is fully equal to their abundance; the mine is 300 *varas* (834 ft.) in depth, which, even at Guarisamey, is an extraordinary circumstance, few of the oldest mines exceeding 100 or 140 *varas* (278 to 389 ft.).

Near the summit of the mountains that separate San Dimas from Guarisamey, lie the mines of Bolanos and Piramide, with others, all of inconsiderable depth. The "bonanza" of Bolanos, upon its first discovery, was celebrated; but the mine was abandoned in consequence of the failure of an adit, commenced with great magnificence, but so badly conducted that, after wandering in various directions in search of the lode, at a very considerable expense, it came out again on the side, at a very little distance from the point where it had entered the mountain.

On the north side of the same ridge, lies the famous mine of La Candelaria, from which a very large portion of Zambrano's fortune proceeded. It is situated near the summit of the mountain, immediately opposite to the mines of Cinco Senores and Bolanos, there being about three hours of difficult ascent from Guarisamey to these mines, and nearly the same from San Dimas to the Candelaria. On the San Dimas side, the mountains are very precipitous; and thus the mine of Candelaria has been worked to the depth of nearly 600 *varas* (1670 ft.), by adits driven one below the other upon the lode. The last, a most magnificent work, is driven nearly 500 *varas* (1390 ft.) into the mountain, with such amplitude that a stage-coach might pass through it into the very heart of the mine, which may be worked 600 *varas* (1670 ft.) lower by pursuing a similar plan. The rich ores of the lode have been found, from the surface to the present depth, in separate beds, perpendicular to the horizon, and divided by intermediate masses of rock. The beds of ore have been constant from the surface downwards, and in that part of the lode hitherto examined, which comprises a horizontal distance of near 500 *varas* (1390 ft.), there are 4 deposits of ore, with an equal number of intermediate *cavallos*, or layers of rock. The lowest levels of the Candelaria are now 100 *varas* (278 ft.) beneath the last adit.

A little below Guarisamey, and in the same ravine, is the district of San José Tayoltita, which contains the celebrated mine of La Abra, one of the last worked by Zambrano. It was opened in "bonanza," and continued so to the depth of 100 *varas* (278 ft.), where the progress of the works was impeded by water; and this was never drawn off, in consequence of the death of the proprietor. His nephew, at the commencement of the Revolution, collected what money he could, by extracting the pillars of all the mines belonging to the house of Zambrano, and fled to the Peninsula with the produce. The mine would, if worked anew with the other mines of the district, with a little science and activity, probably yield immense profits.

Tamasula, Canelas, and Sianori are all valuable districts, the two last of which are situated on the extreme north-western boundary of the state of Durango.

Upon the western descent of the Sierra Madre, 80 leagues from Chihuahua, is the celebrated and recently discovered district of Jesus Maria. This mining district was "denounced" in 1822, but was little worked in consequence of scarcity of provisions, population, &c. It was in fact nearly abandoned until 2 or 3 of the most promising lodes, having been worked to the depth of 15 or 20 *varas* (42 to 56 ft.), began to yield very rich ores. Upwards of 200 lodes were discovered in one year in a circle of 3 leagues in diameter in the neighbouring mountains. In consequence of the poverty of the miners, few mines were worked deep. The deepest (Santa Juliana) is not more than 70 *varas* (194 ft.), but has produced ores so rich that they were carried 80 leagues to Chihuahua and 130 leagues to Parral to be reduced. Near the surface of the earth, all the lodes contain a considerable quantity of gold; this diminishes as the workings increase in depth, while the proportion of silver augments. In the immediate neighbourhood are several mining districts of very great promise, some ancient, and some newly discovered. Such are Rosario, Nabosayguame, El Potrero, Quipore, El Pilar de la Cieniguita, El Pilar de Milpillas, Batopillilas, and Cajurichic. These form a circle, the centre of which is the Indian village of Moris. Jesus Maria is near the summit of the mountains, and cold in winter. Moris is in a temperate climate, almost bordering on the Tierra Caliente.

The road from Guaymas to the interior of Sonora lies through the town of Petic, situated near the confluence of the rivers Dolores and Sonora; 14 "leagues" to the west of Petic is the town of San Miguel de Horcasitas, on the river Dolores. To the north of this town, the first ramifications of the Sierra Madre in Sonora appear, abounding in mines of gold, silver, and copper; this latter bears a high price (and is sent to China) in consequence of the large proportion of gold contained in it.

From San Miguel to Ures, on the south bank of the river Sonora, the distance is 12 "leagues." To the north of this town, the road runs along the banks of the river Sonora, confined in its course by two of the precipitous ridges which branch out from the great Cordillera, and intersect the level country at regular intervals. These ridges preserve generally the same direction (from N. to S.), and run parallel with each other towards the Pacific, separated by the rivers Dolores, Sonora, Oposura, and Barispe. In all these streams gold has been found, but in none so constantly as in the river Sonora, the mountains on either side being nearly perpendicular, and full of mineral veins.

The general opinion is that the riches of the Sierra Madre are very great, Glennie terming it "one mine" from Guarisamey to Jesus Maria.

To the north-east of Alamos (in Cinaloa), and nearly due west of Jesus Maria, upon the slope of the Sierra Madre towards the Gulf, lies the mining district of San José de Mulatos, discovered in 1806, and registered as a *placer de oro*, on account of the quantity of gold found in the small stream which descends from Mulatos to the river below. On investigating the ravine from which this stream issued, three elevated crests were discovered, one of them more than 100 *varas* (278 ft.) high, intersected in all directions by small threads or veins of white earth, containing gold in so large a proportion that the ore of inferior quality was disposed of at $12 and $15 (50*s.* to 62*s.* 6*d.*) the *arroba* (25 lb.); while the richest sold for $200 (40*l.*). Two of the crests have been extensively worked, but the third is nearly virgin. All three may be explored to advantage by commencing at the summit, and sinking through the crest to the level of the ground, as the veins of gold traverse every part of the rock. The gold is nearly pure, containing only ½ gr. of alloy. Glennie found a number of Indians suspended by ropes from the crests, picking out the earth containing the gold with wooden stakes.

Cosala, 35 "leagues" south of Culiacan (the largest town in Cinaloa) derives its importance from its mines, one of which, called Nuestra Señora de Guadalupe, is celebrated. The proprietor refused the offer made in 1825, by an association, of $1,000,000 (200,000*l.*) to be allowed to work the mine for 3 years. It is free from water, and situated considerably above the plain; it contains a vein of gold of considerable breadth, and its produce might be increased 10 times; but the proprietor often does not work it for months, and when compelled to do so to prevent losing his title, never allows more than 4 *arrobas* of gold (100 lb.) to be raised in a week!

At Comanja, between Lagos and Leon, is another district. The principal vein of Comanja is considered to be a prolongation of the Veta Madre of Guanajuato.

Colonel Bourne, speaking of the river Sonora, says that no doubt great quantities of gold might be taken out by intelligent people, as it is natural that the larger grains should bury themselves at some great depth, and the natives never think of looking below 1 ft. deep in the sand. The ridge on the left of this ravine is full of mineral veins, all of which contain more or less gold; and as gold in grains is generally discovered on or near the surface, it is very probable that in the shelves and interstices of these mountains, a large quantity of gold is deposited by the tremendous periodical rains.

Babiacora is on a table-land about 1 mile from the river Sonora; in its neighbourhood are many silver-mines, most containing a greater or less proportion of gold. The principal are Dolores and San Antonio to the south-west of the town, Cerro Gardo to the south-east, and Cobriza on the Cerro de San Felipe, in the valley above.

To the north is the mining district of Nacosari, 16 "leagues" from Oposura, and 14 east from Arispe. The mines of Churunibabi, Pinal, Huacal, Aguage, and many others, are equally rich with the above; but

Pinal contains more gold than silver. To the west of Arispe, are the mines of Santa Theresa, of gold and silver, completely virgin; and the mountain of San Pedro contains innumerable mines and veins untouched. The mines of La Agame, near Horcasitas, are famous for the abundance and richness of their gold-ores. In the plains of Sonora, beds of native gold have been found in grains, varying in size from 1 to 60 oz., as in Cieneguilla, San Francisco, San Antonio de la Huerta, Mulatos, Baucachi, and various others.

Sevin (1860), alluding to the town of Jesus Maria, in the Sierra Madre, on the head waters of the Rio Mayo, and near the frontier of the state of Sonora, says that its gold-mines have at times been very rich. The Mina del Rosario, even lately, has yielded $10,000 (2000*l.*) of gold every week. At the present moment, it is abandoned. In general, gold-mines are thought less valuable here than silver-mines. They are less constant, the stealing of the ore is more easy, and their failure may in a short time destroy the capital invested. The gold of Mulatos, as well as of Jesus Maria, is extracted by a real mining process from the rocks *in situ*. Mulatos is situated in the extreme south-western corner of the state, 120 "leagues" distant from the city of Chihuahua. Its mines were very rich at the time of the Spaniards, but have been abandoned since their expulsion. From time to time, however, some poor people make a living by collecting a small portion. The silver-ores of Jesus Maria always contain gold in a sufficient ratio to make the *marc* (½ lb.) worth $10 (2*l.*). Immense wealth was extracted from its numerous mines in the time of the Spaniards. The mine called Santa Ludubigen has been worked since the expulsion of the Spaniards. In the 6 months from May to October 1839, it yielded a net profit of $400,000 (80,000*l.*); and during 1845–46, again $500,000 (100,000*l.*) were cleared by the concern. The chief mine is the Santa Juliana, which has never been worked since the Spaniards' time. It is 300 *varas* (278 yd.) deep, and now full of water. It would require $200,000 (40,000*l.*) to commence working it again on an adequate scale.

Corralitos is situated in the northern part of the state, on the Rio de las Casas Grandes, which empties into the Laguna de Guzman. This place is distant about 90 "leagues" from the capital of the state. The silver here carries gold, making the *marc* (½ lb.) worth $9⅘ (39*s.* 7*d.*); but the Apache Indians, who live in the neighbouring mountains, render the road to the capital unsafe, and thereby make necessaries very dear.

Yuguivo, in Chihuahua, near the capital, has several rich mines; many have never been worked, and those that have are abandoned. The silver contains a large proportion of gold.

At Cerocahuic, 8 "leagues" from Sententrion, and 12 "leagues" from Batoseagachic, the silver contains a considerable proportion of gold.

Water-power is near, the mountains are covered with fine forests; but no regular mining operations have been tried, although promising success.

In the neighbourhood of the Indian town of Tubares, on the western side of the Rio Grande, several rich gold-mines on large regular veins were worked by the Spaniards; but since their expulsion, the mines have been abandoned, and their locality is now unknown.

The great auriferous copper, silver, and lead vein, called La Purisima and Dos Amigos, in Huacaivo, Chihuahua, reported on by D'Aumaile in 1861, passes diagonally through the valley of Papigochi, from N.E. to S.W., and runs across the river Fuerte, near the Indian village of Satesicochi, in a general N.N.E. course. It dips E. at an inclination of about 45° on the tops of the highest hills, but soon takes a much more perpendicular pitch, and in the lowest visible portion, above the bed of the Fuerte, has already an angle of nearly 60°.

The width between vein-walls may be set down at 20 to 25 ft., but this width is filled up by various distinct lesser veins of copper, gold and copper, and silver and copper, and divided by their respective *lisos*. The country is dioritic; the vein is remarkably well defined, and bears all the indications of being a true vein.

In one of the narrow seams of the hanging-wall, directly above the "winze" (*pozo*) of San Cristobal, was made the first discovery of gold in a matrix consisting of gossan and a red talcose or steatitic matter heavily charged with peroxide of iron. The deposit was superficial, and yielded about 10 oz. per ton. Soon afterwards, the adits of Dolores and Monserrate, and the "winze" de la Trinidad were opened. The ores from the former gave from 6 to 7 oz. per ton, but are now not so rich; those of Monserrate and neighbouring workings, 1 to 6 ft. in width, give ore of 3 to 6½ oz. per ton.

That of Trinidad is very soft and very wide, but yields only $15 (3*l.*) per ton; this, which would be considered good paying ore in California is not worked.

From 2 *cargas* (600 lb.) of the last ore blasted out of San Pedro, were extracted 5½ oz. of gold, besides a considerable amount which remained in the concentrated tailings (*polvillos*). The gold is of very handsome appearance, and gives by assay 888·75 of gold, 82·25 of silver, ·029 copper, with lead and a little tin. In the Frente de San Pedro, they have already struck one of the seams of the upper wall 4 or 5 in. thick of solid sulphuret, and in this the gold becomes more heavy and massive. A portion of this ore yielded per ton (2000 lb.) of copper, 576·32 oz. of gold, and 128 oz. of silver, which, at $18·20 (75*s.*) per oz. for gold = $10,489 (2185*l.*). From the copper smelted from the residue of the gold-washings, D'Aumaile extracted gold 1216 oz. = $22,131 (4615*l.* 12*s.* 6*d.*) per ton (2000 lb.) of copper.

A miner brought D'Aumaile an ore, which he declared to be from a narrow seam in the hanging-wall (*respaldo alto*) of the Veta Fornelli, giving "141 oz." (? gold) "per ton. He petitioned for leave to work the same on his own account, cleaning and delivering the copper ores to the proprietors, free of expense."

Montezuma, in the second expedition of Cortez, stated that the richest gold-mines were in the province of Zacatula. He also described the method in which the gold was obtained, namely, by washing the earth, the small grains of the metal sinking to the bottom.

Phillips (1854) states that gold occurs in its pure state in various parts of Mexico, "in Sonora, in El Doctor, near Tasco, and recently it is said to have been discovered in the river Mescala."

Much valuable information is contained in the notes collected by Rémond, and edited by Whitney, according to which, the best mining districts in Mexico, in order from south to north, are, in Durango, San Antonio de las Ventanas, Guarisamey, and San Dimas, remarkable for their auriferous silver-ores; and 62 Mexican "leagues" N.E. of Mazatlan, Jesus Maria in Chihuahua, and Real de la Cieneguita, Sonora, with gold-mines. The igneous rocks are granite, either fine or very coarse-grained; porphyries, more or less felspathic; and greenstones, all of which are cut by dykes of extremely varied character. The granites, however, are very poor in veins of the precious metal; while the porphyries are highly metalliferous. The Triassic forms isolated mountain groups in Sonora. It is made up of heavy beds of quartzites and conglomerates, with coal-bearing shales; all of these are disturbed and elevated, and rest on greenstones, felspathic porphyries, or granite. Wherever metamorphosed, the Triassic rocks are auriferous. The metamorphic slates and limestones of the Altar and Magdalena districts, which include the richest gold-placers of Sonora, may possibly be of Triassic age, but the fossils collected are too imperfect to admit of this being determined. There are some reasons for believing those rocks to be rather of Jurassic than of Triassic age, as they differ in lithological characters from both the Triassic and Carboniferous of Northern Mexico, resembling rather the Jurassic gold-bearing slates of the Sierra Nevada in California; besides, they lie outside and west of the Sierra Nevada. It may also be noticed that the gold which they furnish does not resemble that obtained from the Triassic strata.

At San Marcos, between San Antonio de la Huerta and the Real Viejo, metamorphic jaspery slates occur in connection with the Carboniferous limestones; they are probably of Triassic age. Gold is found in the gulches between the quartzite ridges, as in the Cañada de la Higuera, near Los Bronces in the Cañada de la Iglesia, between the latter place and San Antonio de la Huerta, and generally where quartzites occur.

In Durango and Sinaloa, gold, native silver, and sulphuret of silver occur associated with galena, yellow blende, and iron pyrites.

A tabular statement showing the position and character of the principal mines of Northern Mexico is given by these authors, from which the following notes are taken:—

La Blanca, near San Antonio de la Huerta: country, quartzite and conglomerate—Triassic; N. and S. strike; dip, 15° E.; matrix, vesicular quartz; ores, gold and chloro-bromide of silver; yield per ton, $43 (8*l.* 19*s.* 4*d.*).

Santa Barbara, near Corral Viejo: country, quartzite; strike, N.E. to S.W.; dip, 30° S.E.; width, 1½ ft.; matrix, quartz; ores, galena, carbonate of lead, iron pyrites, gold; yield per ton, $67 57c. (14*l.* 2*s.* 3*d.*).

Carmen, location Candelaro: country, porphyry-metam.; strike, N. 85° E.; dip, 85° N.; width, 28 ft.; matrix, quartz; ores, silver and gold, sulphuret of silver; yield per ton, $186 65c. (38*l.* 17*s.* 8*d.*).

Atocha, location Candelaro: country, porphyry-metam.; strike, N. 45° E.; dip, 85 °N.; width, 14 ft.; matrix, quartz; ores, silver and gold, sulphuret of silver; yield, $213 35c. (44*l.* 9*s.*).

Rosario, Candelaro: country, porphyry metam.; strike, N. 50° E.; dip, 70°–80° N.W.; width, 17 ft.; ores, silver and gold, sulphuret of silver; yield, $160 (33*l.* 6*s.* 8*d.*).

Bolanos, near San Dimas: country, porphyry metam.; strike, N. 45° E.; dip, 75° S.E.; width, 20 ft.; matrix, white quartz; ores, galena, blende, gold.

Babicanora: country, limestone (Carboniferous); strike, N.E.–S.W.; dip, 75° N.W.; width, 5 ft.; matrix, quartz; ores, galena, iron pyrites, fahlerz, ruby silver ore, gold, and silver.

Writing to the *Mining Journal* (xliii. 1094) in 1873, J. H. Petherick stated that the gold-fields on the Rio del Oro, Distrito de Mino, were opening up profitably. In the El Puerto concession, a lode had just been intersected, the vein being composed of sulphurets; 1 ton 16 cwt., sent to London, assayed 17 oz. of gold and 28 oz. of silver per ton, realised 72*l.* per ton, and gave a profit of nearly 200 per cent. after paying all expenses of extraction, freights over 200 miles land-carriage and by ocean steamer, and treatment. The mines on the eastern and western banks of the river are worked by English and American residents, and are increasing their returns. There are deep runs of auriferous ground in these possessions, as in Australia and California, which have to be explored. The shallow alluvial has afforded a living to hundreds of natives for many years past, who extract the gold by the *batea* only.

According to Bates, virgin gold is seldom found at Tepeyac, and not in compact masses. It occurs in seams, consisting alternately of quartz, sparry spherosiderite and limestone, amethyst, chalcedony, and hornstone. But in a porphyritic mountain at La Candelaria, near Guarisamey, pure compact gold is found both in laminæ and disseminated in quartz and calcite seams. Pearl gold has become rare in Pachuca, while it is found mostly efflorescent or disseminated in the mines of La Luz and San Bernabé.

The gold production of Mexico from the date of the independence of the republic (1822) to 1875, has been stated at $47,327,383 (9,859,871*l.*).

Laur gives a table of the annual coinage of gold and silver at the Mexican mint, from the year 1690 to the year 1850, in *piastres* (each worth 37·647*d.*), from which it appears that the total value of gold coin issued in that period was 89,631,866 *piastres* (or more than 14,000,000*l.*).

Prof. Soetbeer has compiled a table of the approximate yearly production of Mexican gold, in periods, stated in *pesos* (each of a value of 4*s.*), as follows:—

1522–1544	135,250	1621–1640	255,500
1545–1560	100,800	1641–1660	236,300
1561–1580	230,600	1661–1680	231,900
1581–1600	308,400	1681–1690	222,200
1601–1620	269,900		
	MINTED.		
1691–1700	220,000	1771–1780	867,000
1701–1710	270,000	1781–1790	552,000
1711–1720	330,000	1791–1800	934,000
1721–1730	390,000	1801–1810	1,072,000
1731–1740	390,000	1811–1820	603,000
1741–1750	528,000	1821–1830	550,000
1751–1760	411,000	1831–1840	487,000
1761–1770	654,000	1841–1850	1,123,000
1851	1,230,268	1857	828,526
1852	1,291,809	1858	596,063
1853	1,217,472	1859	832,372
1854	965,412	1860	574,634
1855	956,222		
1856	995,813	Average 1851–1860	948,859
1861	1,130,158	1867	871,537
1862	929,487	1868	982,898
1863	1,059,696	1869	1,026,300
1864	871,704	1870	1,182,628
1865	930,996		
1866	1,010,131	Average 1861–1870	1,000,453
1871	1,150,512	1874	866,744
1872	1,113,007	1875	862,619
1873	813,415	1876	806,417

The total from 1861 to 1876 is 15,617,249 *pesos* (3,123,450*l.*).

Danson places the total Mexican gold-production from 1521 to 1848 at 163,920,225 *pesos* (32,784,045*l.*); Michel Chevalier states it at 389,269 *kilos.* (856,391·8 lb.,) or 1,341,000,000 fr. (or nearly 54,000,000*l.*).

The recapitulatory table given by Prof. Soetbeer may be translated as follows:—

Years.	Weight.	Value.
	lb.	£
1521–1690	133,760	30,746,500
1691–1810	243,221	
1811–1850	107,910	
1851–1875	98,197	6,226,600
Total ..	583,088	36,973,100

NICARAGUA.—Perhaps the most diffuse information concerning the gold-mines of Nicaragua is contained in the work (1874) of Thomas Belt, who was for some years the resident manager of the extensive mines belonging to the Chontales Co., situate in the village of Santo Domingo, province of Chontales, in lat. 12° 16′ N., and long. 84° 59′ W. The rocks of the district are dolerites, with bands and protrusions of hard greenstones. The decomposition of the dolerites is very great, and extends from the tops of the hills to a depth, as proved in the mines, of at least 200 ft.

Gold-mining at Santo Domingo is confined almost entirely to auriferous quartz lodes, no alluvial deposits having been found that will pay for working. The lodes run E. and W., and are nearly perpendicular, sometimes dipping a little to the N., sometimes a little to the and near the surface, generally turning over towards the face of the hill through which they cut. The trend of the main ranges, also nearly E. and W., is probably due to the direction of the outcrops of the lodes, which have resisted the action of the elements better than the soft dolerites. The quartz veins now form the crests of many of the ranges, but are everywhere cut through by the lateral valleys. The beds of dolerite lie at low angles, through which the quartz veins cut nearly vertically, excepting that they are very irregular in thickness, and often branch and send thin offshoots into the enclosing rocks; they resemble coal-seams that have been turned up on edge, so as to be vertical instead of horizontal. They run for a great distance. Near Santo Domingo, they have been traced for 2 miles in length, and probably they extend much further. They are what are called fissure-veins.

The gold-mines of Santo Domingo are in veins or lodes of auriferous quartz, that run parallel to each other, and are so numerous that across a band more than a mile in width, one may be found every 50 yd. All that have been worked vary greatly in thickness; sometimes within 100 yd. a lode will thicken out from 1 to 17 ft. Their auriferous contents vary still more than their width. The rich ore, worth from 1 to 4 oz. per ton, occurs in irregular patches and bands, very small in comparison with the bulk of the ore stuff, which varies in value from 2 to 7 dwt. per ton. The average value of all the ore treated by the Chontales Mining Co., up to the end of 1871, had been about 7 dwt. per ton, and during that time small patches were met with worth 100 oz. of gold per ton. The gold does not occur pure, but is a natural alloy of gold and silver, containing about 3 parts of the former to 1 of the latter. The quartz lodes also contain sulphate of silver, peroxide of manganese, peroxide of iron, sulphides of iron and copper, and occasional lead ores.

The quartz is generally very friable, full of drusy cavities, and broken up into innumerable small pieces, that are often coloured black by the peroxide of manganese. The gold is in minute grains, and generally distributed loose amongst the quartz. Pieces as large as a pin's head are rare, and specimens of quartz showing the gold in it are seldom met with, even in the richest portion of the lode. The fine gold-dust can, however, easily be detected by washing portions of the lode-stuff in a horn. The quartz and clay are washed away, and the gold-dust sinks to the bottom, and is retained in the spoon. This is the usual way in which the lode is tested by the mining agents, and long practice has made them very expert in valuing the ore by the wash in the "spoon." Although most of the gold occurs loose, amongst the soft portions of the lode, the hard quartz also contains it disseminated in minute grains.

One feature in the distribution of gold in the quartz lodes of Santo Domingo, led to a most exaggerated opinion of their value when they were first mined by English companies.

On the hills, near the outcrops of the lodes, the ore was in some places exceedingly rich: 100 oz. of gold were obtained from a small patch of ore near the surface of the Consuelo lode, and at Santo Domingo, San Benito, San Antonio, and Javali lodes, very rich ore was also discovered within a few fathoms of the surface. When, however, these deposits were followed downwards, they invariably got poorer, and at 100 ft. from the surface, no very rich ore has been met with. Below that, when the works are prosecuted still deeper, there does not appear to be any further progressive deterioration in the value of the ore, and it varies in yield from 2 to 7 dwt. of gold per ton, upon which yield farther depth does not seem to have any effect. These rich deposits near the surface are obviously due, not to the lodes having originally, before they were exposed by denudation, contained more gold in their upper portions than below, but to the effect of the decomposition and wearing down of the higher parts, and the concentration of the gold they contained in the lode below that worn away. In the decomposed parts of the lode, the gold exists in loose fine grains: during the wet season, water percolates freely from the surface down through the lodes, and the gold set free by the decomposition of the ore at the surface must be carried down into it, so that, in the course of ages, during the gradual degradation and wearing away of the surface, there will have been an accumulation of the loose gold in the upper parts of the lodes from portions which originally stood much higher, and have since been worn away by the elements.

The mining is entirely executed by the native workmen, principally Mestizos from the border-lands of Honduras and Nicaragua, where they have been engaged in silver-mining.

The band of auriferous quartz veins worked at Santo Domingo continues westward for 8 miles, as far as the savannahs near Libertad, and has been largely mined in the neighbourhood of that town, and between that point and Santo Domingo. Besides the working of the mines proper, some surface deposits, called by the Spaniards *mantas*, are also worked for gold, especially in the neighbourhood of Libertad. The *mantas* consist of broken quartz, covering the faces of the hills in the neighbourhood of some of the lodes. In some places, they form a disjointed but regular stratum over the whole side of the hill; and Belt accounts for their origin by supposing them to be a further development of the tendency of the lodes near their summits to incline over towards the face of the hill through which they cut. In the San Antonio mine, the lode is in part bent completely round; this bending over in the lodes is always towards the face of the hill, and Belt thinks it is produced by successive small land-slips.

In the course of his work, Belt briefly alludes to the scarcity of alluvial gold deposits in Nicaragua, and attributes this to glacial denudation, which removes the whole surface passed over, and does not, as in the case of water-worn areas, permit the gold to exert its specific gravity and arrest its movement.

Dr. Scherzer, writing in 1857, or 14 years earlier than Belt, says that of the precious metals very little is obtained in Nicaragua; the most important works of this kind are the gold-mines of Santa Rosa de Venci, 24 "leagues" north of Leon; and those found in the province of Chontales in 1849.

The mines of Chontales lie about 50 miles from the sea coast, 114 N.E. from the town of Granada, and 36 from Lake Nicaragua. The mining region extends over an area of about 80 miles, and lies 1500 ft. above the Atlantic Ocean. The metal is found in quartz, red sandstone, and slate; "the works are not carried on systematically, but by a crowd of adventurers who go rummaging almost at random in the bowels of the mountain." In 1854, there were about 300 men at work here: they came chiefly from the mines of Honduras, in the hope of higher wages, and were a motley crowd of North American, Irish, French, and German vagabonds, who used to go digging to-day here, to-morrow there, and consuming in the evening what they had earned during the day. The population attracted to this lonely mountain district in search of gold did not, however, altogether amount to above 600 persons, while the Indian population of the province of Chontales amounted to 10,000. Up to March, 1854, no gold from Chontales had ever found its way into commerce, nor had any chemical analysis been made of the metal contained in the ore; but at that time, some specimens were brought that appeared so extraordinarily rich and productive, that a regular gold-fever broke out in Granada, and there was a rush to the district of all who could by any means manage to travel the 12 "leagues," while new speculators arrived every day from the United States, and set about forming joint-stock companies. The great hindrance, however, to the profitable working of the mines of Chontales, was the want of well-informed miners, as well as of good roads and sufficient capital.

In the environs of Teustepet, gold, silver, and copper have been found; but nothing has been done towards a systematic working.

The mines of Matagalpa were discovered in 1808, but did not attract the attention of large capitalists till 1814. At that time, more than 200 men were employed in the mines, and the yearly produce was calculated at 80,000 *piastres* (12,500*l.*) The produce in 1857 was not more than a quarter of that amount, and there were but 60 workmen.

Scherzer visited the most important mines of Matagalpa, and came upon the first at about 2 "leagues" S.E. of Matagalpa. The greatest mining works begin at San Ramon; and the utmost that has ever been obtained from them amounted to 33 lb. of gold, equal to a value of $5000 (1000*l.*). To obtain this much, 12,000 cwt. of quartz had to be got from the interior of the mountain, and crushed. This is equal to 13 dwt. 5 gr. per ton.

The tools and mining apparatus are perhaps the most primitive employed in any quarter of the world, consisting merely of a crowbar and an iron hammer, with a wooden crushing-machine made in the country; and the whole process is quite independent of the discoveries of modern technical chemistry. A workman's wages at these mines are little more than from 10 to 15*d.* a day with his food; and an ounce of gold costs—or did cost—$15 (3*l.*).

The second mine visited was that of La Leonesa, where a perpendicular depth of 270 ft. has been reached, and 7 galleries opened. These works also, however, were stopped for want of capital. The mineral veins usually run from N.E. to S.S.E.

At a distance of a league from San Ramon, lie the gold-mines of La Luna, and farther on those of Monte Grande, Ucalca, and San Pablo.

At the mine of San Rafael, ½ a "league" from Dipilto (which is the last Nicaraguan town towards the Honduras frontier), although it has been opened only 3 years, a perpendicular depth of 150 ft. has been attained, and 10 horizontal subterranean galleries formed of more than 2 "leagues" in extent. The principal and most productive veins in these mines run from E. to W. The produce of silver varies extremely. In general, it is considered to be 3 to 6 oz. from 25 lb. of ore; but sometimes the same quantity of ore will yield as much as 24 oz. The silver is mostly found united with lead, copper, or gold, but only with the first in sufficient quantity to pay for the separation. Of gold, not more than 20 oz. have been obtained from 25,000 lb. of the rock, which is nearly 2 oz. per ton.

The gold-region of Guyappa is bounded on the east by the valley of Lepaguare. The river Guyappa is a branch of a larger river between the district of Olancio and the valley of Lepaguare, and empties into the Caribbean a little to the south of Truxillo.

Froebel states that Matagalpa seems to form part of an extensive gold-region, reaching from the sources of the Bluefield River northward to the valleys of the Upper Patook or Guayape, in Honduras.

According to Squier (1860), the northern districts of Nicaragua,—Segovia, Matagalpa, and Chontales,—adjoin the great metalliferous mountain region of Honduras, with which they correspond in climate, and with which they are geologically connected. They are rich in gold, copper, iron, and lead, the ores of which are readily worked.

Nearly all the streams to the eastward of the town of Nueva Segovia, falling from the mountains of Honduras into the Rio Coco, or Wanks, carry gold in their sands, in greater or less quantities. The Indians, and a few adventurers from other parts of the state, carry on washings in a small and rude way, and consequently without any great aggregate result. In the neighbourhood of Matagalpa, on the headwaters of the Rio Escondido, are also gold-washings worked in like manner by Indians.

In the district of Chontales, among the mountains separating the waters flowing into Lake Nicaragua from those falling into the Rio Escondido, the ores of gold are found in abundance. There are numerous evidences that the mines were largely worked by the aborigines. The metal occurs chiefly in quartz veins. Attempts were made in 1856–57 to introduce proper machinery for crushing the rock and extracting the metal, but the political condition of the country has been such as to break up and discourage all enterprises of this kind. Whenever order shall be permanently established, Chontales will no doubt command increasing attention. Its accessibility from the shores of Lake Nicaragua, and through the navigable waters of the Rio Escondido, point it out as the most favourable mining region in Nicaragua.

Some explorations of Indian River, flowing into the Caribbean Sea on the Mosquito shore, a short distance above the port of San Juan, disclosed the fact that gold exists in that stream, as it does unquestionably in all the rivers falling from the mountains of Honduras into the Atlantic. It may be questioned, however, if the gold, except in peculiar localities, can be obtained in sufficient quantities to repay the cost and labour.

The methods of mining in Nicaragua, as in every other part of Central America, are exceedingly rude, and it is not surprising that the results are so often unsatisfactory. The silver and gold ores are crushed in a basin of masonry, in which rises a vertical shaft, driven generally by a horizontal water-wheel. This shaft has two arms, from each of which is suspended a large stone or boulder. These are the crushers. After the ore is reduced to sufficient fineness, the metal is separated by mercury: "a long and expensive process, which is now beginning to be facilitated and cheapened by the introduction of the German or 'barrel process.' The machines for crushing the ores have, however, as yet, undergone but slight improvement."

Byam has the following reference to the gold-washings of the country. Some adventurers, generally of the very lowest class, both in manners and morals, proceed to the auriferous streams that run through the south part of the Honduras nearest to Segovia, for 2 or 3 months during the driest part of the year, and when the rains have entirely subsided. The part of the country is almost uninhabited, and on the arrival at the different streams, each man and his female helpmate generally choose a spot, often miles from their neighbours, where they commence operations. The first thing is to build a *ramada*, or hut of branches, as the name signifies; but they always select a place where two good-sized trees are near enough together to enable them to swing their hammocks between them. The man is always within sight of the hut, in case assistance be wanted in such a wild spot; and he digs holes into the ground near the stream, and after having piled up a heap of earth close to the water, washes it in half-gourds, when, after repeated changes of water, and the spot chosen having proved a good one, a little fine gold-dust is often visible in the gourd. It requires a great deal of nicety to balance the gourds backwards and forwards, up and down, and round about, so as to get rid of the earth; and it is still more difficult, at the last washing, to manage to leave the gold all together at the very end of the remaining deposit, which is generally of a black or dark-grey colour. The grains of gold are often large enough to be picked out after one or two washings, and even to be discovered whilst digging; and a man in good luck may find enough gold in a week to keep him comfortably the whole year.

Samples of ore brought to England by Truran from the Chontales Co's. mines assayed from 1 dwt. up to 174 oz. 10 dwt. of gold per ton of ore; the average of 31 analyses, neglecting two which gave respectively 174 oz. 10 dwt. and 39 oz., was a little over 2 oz. 6 dwt. 4 gr. per ton.

UNITED STATES.—The auriferous regions of the United States are divided between two distinct and distant mountain ranges: the first and by far the more important being what may be called the Pacific Coast range, including the Rocky Mountains, the Sierra Madre, the Black Hills, and the Sierra Nevada, which, with the Andes and intermediate mountains, form one continuous gold-bearing region extending from Alaska to Patagonia; the second, which was in reality the first discovered by European colonists, being the Alleghany range, on the eastern [Atlantic] coast.

Old chroniclers give an account of a province called Cofachiqui, which was visited by the Spaniard De Soto's gold-hunting expedition in 1538–40, and which was embraced in what afterwards became the States of Florida, Georgia, Alabama, and Mississippi, and, according to Logan, had its centre on the western limits of South Carolina. Its capital and chief town stood upon the tongue of land between the Broad River of Georgia and the Savannah, just opposite the modern district of Abbeville. The Spaniards entered this capital after a two months' march, and there found hatchets formed from an alloy of gold and copper. At this their cupidity was greatly excited, and they concluded that they had found a country abounding in the long-coveted precious deposits of gold. And so indeed they had: less than 15 miles south-east of the town, on the opposite or Carolina side of the river, lay one of the most extraordinary gold-deposits in the world. The Cherokees were well acquainted with the Dorn mine. This is shown by the numerous relics of their handiwork scattered around it, and there can be little doubt that the massive nuggets of its outcropping gold supplied them abundantly with the finer metal of the alloy that so attracted the Spaniards. It is no less known that the gold and copper, found in the possession of the Indians, in the form of solid masses or curious trinkets, by the first white men who visited the country, were obtained from these sources.

The Indian method of smelting these metals was one of the most remarkable devices of savage ingenuity; in practical efficiency the modern blowpipe is scarcely superior. Logan says that, having first hollowed out a flat stone in the form of a basin, they filled it with charcoal, and upon this laid the nuggets of metal. A number of Indians then seated themselves in a circle around the basin, each one having in his hand a long reed, pierced through its entire length, and armed at one end with a clay tube or pipe. Everything being ready, fire was applied to the charcoal, and the whole mass instantly blown into a powerful heat through the reeds, the clay extremities of which were inserted in the basin. In this way the Indians could easily produce any variety of ornament from these metals, using them either alone or in alloy. This method was known to have been in use among the Indians who lived upon the gold-producing lands of North Carolina, and the same process must have been known to the Cherokees. These chronicles and traditions go to confirm what Lawson says, that the Indians, from time immemorial, were acquainted with valuable mines of gold and silver in Upper Carolina.

The Spaniards under De Soto, led on by stories, exaggerated or misunderstood, of their Indian guides, made a wide superficial exploration in search of the origin of this treasure. They are supposed to have excavated many of the diggings in North and South Carolina and Georgia, which are now overgrown with forests. But no rich deposits appear to have been discovered, nor permanent operations undertaken.

In the great charter of King James, by which, in 1606, the right to explore and settle the North American continent from the 34th to the 45th parallel, was granted to the London and Plymouth companies, it was provided that one-fifth of the gold and silver, and one-fifteenth of the copper, which might be discovered, should belong to the crown. One of the earliest expeditions of Capt. John Smith, in Virginia, was the exploration of the Chickahominy River, in the hope that it might constitute a water-way to the Pacific Ocean; and one of the next events in the history of the same colony was a mining excitement, caused by the supposed discovery of gold. It is a curious circumstance that gold really occurs in the region; though the glittering dust, of which a ship-load was sent by the deluded colonists to the jewellers of London, proved to be mica or iron-pyrites, a blunder that has had its parallel in modern days.

Already Jefferson, in his "Notes on Virginia," mentioned the finding of a lump of gold weighing 17 dwt. near the Rappahannock; and in 1799, the famous Cabarrus nugget, weighing 28 lb., was discovered at the Reed mine, in North Carolina. But the great gold excitement in the south followed the discoveries in Georgia from 1828 to 1830.

The early gold-production of the Atlantic States, i.e. between the years 1804 and 1850, has been computed by Whitney as follows:—

States.	Value in $.	Value in £.
Virginia	1,198,600	249,708
North Carolina	6,842,900	1,425,604
South Carolina	818,100	170,487
Georgia	6,048,900	1,260,187
Tennessee and Alabama ..	263,800	54,958
Total	15,172,300	3,160,944

In striking contrast to these figures, the production from 1851 to 1867 amounted to only $4,391,915 (914,981*l.*).

The most important event in the history of mining in the United States, says Raymond, was the discovery of gold in California, in 1848. It was previously known to exist in the country, for rumours of it were current among the trappers, and placers had actually been worked in what is now Los Angelos county; but the Padres of the neighbouring mission of San Fernando had discouraged the business as demoralizing to their flocks; and the existence of the precious metal was not widely known; still less was its distribution northward suspected. Stearns, who went to California from Mexico in 1829, says that on the 22nd of November, 1842, he sent 20 oz. California weight (18¾ oz. Mint weight) of placer gold to the U.S. Mint at Philadelphia. The mint assay was returned August 6th, 1843. The gold was taken from placers first discovered in March, 1842, by Francisco Lopez, a Californian, at San Francisquito, about 35 miles north-west from Los Angelos. Lopez dug up some onions with his sheath knife, and in the dirt discovered a piece of gold. A few persons—mostly Sonorians—worked these placers, until the war with the United States disturbed the country, taking out $6000 to $8000 (1200*l.* to 1600*l.*) per annum.

The discovery of gold on January 19th, 1848, at Sutler's saw-mill, on the southern fork of the American River, afterwards famous as Coloma, in El Dorado county, was the beginning of the new epoch. This discovery was made by James Wilson Marshall, a partner in the mill, who observed in the *débris* washed down by the tail-race a glittering fragment of a mineral unknown to him. Suspecting it to be gold, he sought for further specimens, and obtained, in the course of a few days, several ounces of it. Tests subsequently made established its character; and the news spread with great rapidity, arousing intense excitement throughout America, and even in European countries. On March 15th, 1848, a San Francisco newspaper contained a paragraph giving the tidings. In May, the same paper announced the suspension of publication; and the editors and workmen, imitating their fellow-citizens of every class, went off to the diggings. Two years later, the population of California had risen from 15,000 to 100,000; and the gold-bearing zone, extending along the west flank of the Sierra to Oregon, had been put under active exploitation. The placers of the southern counties of Oregon were opened in 1852; those of the John Day and Powder Rivers in 1860. Gold was discovered in Idaho, on the banks of the Peu d'Oreille River, in 1852; but the active development of the territory dates from the discovery of the Oro Fino mines in 1860, and the opening, 2 or 3 years later, of the rich Boise Basin. Montana was found to be auriferous in 1858 (possibly earlier), and in 1860 placer mining was inaugurated. The gulches of Colorado began to be worked in 1859; and that territory was rapidly settled, chiefly by immigrants from the East. In Arizona, gold is said to have been discovered in 1858, on the Gila river. In Nevada and Utah, no gold-placers of importance have been found, though the metal is not entirely absent from the mountain ravines, and in some instances, particularly at the Comstock lode in Nevada, it constitutes a considerable portion of the value of argentiferous ores.

The first form of gold-mining in these States and Territories was that of digging. The miner loosened the auriferous soil with a pick, and shovelled it into a pan, from which, by skilful manipulation in water, the clay, sand, and pebbles were removed, and the heavier particles of gold-dust left behind. The first improvement on the pan was the rocker; afterwards the "tom" was introduced from Georgia, and with it the sluice. In 1850 and 1851, the two latter devices began to be generally employed, in consequence of the greater convenience of water-supply afforded by the mining ditches. The first ditch of importance was made in 1850; and its success so stimulated imitation that in the course of 8 years, 6000 miles of mining canals had been constructed, at a cost of more than $15,000,000 (3,000,000*l.*), in California alone.

The following table, compiled by Richthofen, shows the gold export from San Francisco in the years 1848 to 1859:—

Year.	Officially declared.		Probable actual sum.	
	in $.	in £.	in $.	in £.
1848	66,000,000	13,200,000	10,000,000	2,000,000
1849			40,000,000	8,000,000
1850			50,000,000	10,000,000
1851	46,457,895	9,291,579	55,000,000	11,000,000
1852	45,779,000	9,155,800	60,000,000	12,000,000
1853	54,965,000	10,993,000	65,000,000	13,000,000
1854	52,045,633	10,409,126	60,000,000	12,000,000
1855	45,161,731	9,032,346	55,000,000	11,000,000
1856	50,697,434	10,139,487	55,000,000	11,000,000
1857	48,976,692	9,795,338	55,000,000	11,000,000
1858	47,548,026	9,509,605	50,000,000	10,000,000
1859	47,640,462	9,528,092	50,000,000	10,000,000
1860	42,325,916	8,465,183	42,325,916	8,465,183
1861	40,676,758	8,135,351	39,176,758	7,835,351
1862	42,561,761	8,512,352	36,061,761	7,212,352
1863	46,071,920	9,212,384	33,071,920	6,614,384

Blake states the production in 1864–1867, as follows:—

1864	..	$56,707,201 (11,341,440*l.*)	1866	..	$44,364,393 (8,872,878*l.*)
1865	..	45,308,227 (9,061,645*l.*)	1867	..	41,676,292 (8,335,258*l.*)

For the years 1860–1877, Raymond gives the following figures:—

1860	..	$46,000,000 (9,200,000*l.*)	1869	..	$49,500,000 (9,900,000*l.*)
1861	..	43,000,000 (8,600,000*l.*)	1870	..	50,000,000 (10,000,000*l.*)
1862	..	39,200,000 (7,840,000*l.*)	1871	..	43,500,000 (8,700,000*l.*)
1863	..	40,000,000 (8,000,000*l.*)	1872	..	36,000,000 (7,200,000*l.*)
1864	..	46,100,000 (9,220,000*l.*)	1873	..	36,000,000 (7,200,000*l.*)
1865	..	53,225,000 (10,645,000*l.*)	1874	..	40,000,000 (8,000,000*l.*)
1866	..	53,500,000 (10,700,000*l.*)	1875	..	40,000,000 (8,000,000*l.*)
1867	..	51,725,000 (10,345,000*l.*)	1876	..	48,000,000 (9,600,000*l.*)
1868	..	48,000,000 (9,600,000*l.*)	1877	..	50,000,000 (10,000,000*l.*)

Professor Soetbeer gives a recapitulatory table, which may be translated as follows :—

Periods.	No. of Years.	Total.	Annual average.	
		lb.	lb.	£
1804-1820	17	132	7¾	490
1821-1830	10	2,420	242	15,345
1831-1840	10	18,700	1,870	116,575
1841-1850	10	387,200	38,720	2,455,800
1851-1855	5	976,800	195,360	12,387,600
1856-1860	5	848,100	169,620	10,755,450
1861-1865	5	733,700	146,740	9,304,650
1866-1870	5	836,000	167,200	10,602,000
1871-1875	5	654,500	130,900	8,300,250
		Total production and value.		
1821-1850	30	408,320	25,891,200*l.*	
1851-1875	25	4,049,100	256,749,750*l.*	
1821-1875	55	4,457,420	282,640,950*l.*	

The gold-production of the several States and Territories in the year ending June 30, 1880, is thus stated by the Director of the Mint :—

Alaska	$6,000	(1,200*l.*)
Arizona	400,000	(80,000*l.*)
California	17,500,000	(3,500,000*l.*)
Colorado	3,200,000	(640,000*l.*)
Dakota	3,690,000	(738,000*l.*)
Georgia	120,000	(24,000*l.*)
Idaho	1,980,000	(396,000*l.*)
Montana	2,400,000	(480,000*l.*)
Nevada	4,800,000	(960,000*l.*)
New Mexico	130,000	(26,000*l.*)
N. Carolina	95,000	(19,000*l.*)
Oregon	1,090,000	(218,000*l.*)
S. Carolina	15,000	(3,000*l.*)
Utah	210,000	(42,000*l.*)
Virginia	10,000	(2,000*l.*)
Washington T.	410,000	(82,000*l.*)
Wyoming T.	20,000	(4,000*l.*)
Other sources	14,000	(2,800*l.*)
Total	$36,000,000	(7,200,000*l.*)

Returns rendered by mine-owners of 7 of the Pacific States and Territories to the 30th June, 1881, show :—

California	$17,286,333	(3,457,266*l.*)
Nevada	2,534,792	(506,958*l.*)
Arizona Territory	554,517	(110,903*l.*)
Idaho Territory	1,541,652	(308,130*l.*)
Oregon	753,613	(150,720*l.*)
Washington Territory	90,000	(18,000*l.*)
Alaska Territory	1,900	(380*l.*)
Total	$23,462,797	(4,692,559*l.*)

The following information is furnished by a special bulletin of the Census Bureau for 1881. California still holds the first place in production of gold. The vast deposits of auriferous gravel continue to yield largely, though their final exhaustion, in view of the enormous hydraulic operations now going on, must be expected at no distant day. This state furnishes 71·47 per cent. of the total product of placer mines, and 51·38 per cent. of the product of deep mines. The discoveries in the Bodie district added greatly to the deep-mine product. The gold-production is $108·30 (22*l.* 11*s.* 3*d.*) per square mile.

The decrease of the yield of the Comstock lode has caused a considerable decline in the product of Nevada. In 1876, the Comstock yielded $18,002,906 (3,750,605*l.*) in gold, but in the census year the yield of the entire Comstock district and outlying veins was only $6,922,330 (1,442,152*l.*) for both gold and silver. The placer yield of Nevada is insignificant. No important gravel deposits having suitable water-supply are known to exist.

The yield in Utah is from a comparatively few rich claims, and varies but little from year to year. The placer yield was only $20,000 (4000*l.*). More than half the ore is milled, although the territory's mining is generally regarded as dependent upon smelting works.

The development of the Tombstone district has given a marked impulse to mining in Arizona. The placer yield is only $30,000 (6000*l.*).

Since 1876, the yield in Idaho has depended largely upon the old placer mines of Boise Basin. The panic of 1876, in San Francisco, seriously affected the Owyhee mines, which had contributed heavily to the annual output. The proportion of placer to deep-mine gold in Idaho is as 60 to 40. The census examination was made too early to include the developments in the Wood River country and the Yankee Fork region. King predicted, when he wrote the census report, that the output of Idaho would be doubled in two years.

Mining is overshadowed in Oregon by other industries. Nearly all the deep-mine gold in the state is from the quartz veins of Baker county.

Gold-quartz mining is conducted on a small scale in Yakima county, Washington Territory, and the Upper Columbia placers furnish more than one-half of the territory's placer yield.

Alaska contains many gold-bearing districts, but the yield has been small. In the census year, $5951 (1190*l.*) in placer-gold was sent to the San Francisco Mint.

Colorado as a producer of gold was fourth in the census year. The placer yield was small.

The Black Hills mines furnish Dakota's yield. The placer product was about $50,000 (10,000*l.*).

Two-thirds of the deep-mine product of Montana is milled. The gravel deposits are valuable, and it is estimated that the placer yield is $1,162,906 (232,581*l.*).

The mines of New Mexico, in 1880, were awaiting the extension of railroads. Many of these mines were difficult and even dangerous of access. The Census Bureau's work there was affected by the assassination of Col. Charles Potter, the expert in charge of the territory. There is rich placer ground in New Mexico, but for want of water little gold has been obtained from it.

In Wyoming, the production was confined to Sweetwater county.

The average fineness of placer-gold in the United States is 0·876. Of the ore mined in the census year, 91·39 per cent. in tonnage was treated at the reduction works, and 8·61 per cent. was left on the dumps. The average result of the working treatment, as compared with assay value, was 81·86 per cent. of the gold contents, 79·68 per cent. of the silver, and 80·40 per cent. in all. The highest average yield was from the Arizona ores—$7·01 (29*s.* 2½*d.*) gold, and $86·24 (17*l.* 19*s.* 4*d.*) silver per ton. Of the total gold-product of the country, 64 per cent. came from deep, and 36 per cent. from hydraulic, placer, drift, and river mines.

After this general sketch of the gold-yield of the United States as a whole, the auriferous states and territories may be considered in detail in alphabetic order.

Alaska.—See pp. 37–8.

Arizona.—The mines of Pima county were the first opened in Arizona, and are yet considered among the best. They are of quartz, but placers have been worked at several points, and those at the Santa Rita Mountains have given good results. South-west of Tucson, in the Papago country, are extensive "dry washings," and the Papago Indians have for years brought gold-dust to the Tucson merchants. Of the quartz lodes, the Cerro Colorado and the Patagonia are the best known. The lodes are argentiferous rather than auriferous.

The best placers were found in Yavapai county in 1863. For several years, large quantities of gold were taken from Lynx Creek, the Big Bug, the Hassayampa, and other streams; and now, at certain seasons, the washings are very remunerative. The county is prolific in quartz lodes, both of gold and silver, but especially the latter. The Accidental mine, in Lynx Creek, has a vein 2 ft. wide; 1000 tons of ore crushed by *arrastres* gave $25 to $75 (5*l.* to 15*l.*) a ton. The Sexton mine, in the Weaver district, is in the famous Antelope Hill, whence the largest gold-nuggets were taken in 1863–4. The gold is free, and the ore crushed in *arrastres* has given $37 (7*l.* 10*s.*) a ton; 3 tons from one of the spurs yielded $573 (115*l.*) in gold. Rich placers have been discovered in the

Santa Maria district, about 80 miles south-west of Prescott. The gold is coarse, but of good quality; the work has to be done by the Mexican "dry washing" system. The largest nugget found was valued at $50 to $60 (10*l.* to 12*l.*).

In Mohave county, the Greenwood mine is one of the largest gold-properties. Some promising gold-lodes have been found in the Cerbat Range, north of the Wallapai Mountains.

Placers are worked near Ehrenberg, in Yuma county, rich gold-dust being found over an area 40 miles long and 15 wide; nuggets worth $2 to $10 (8*s.* 4*d.* to 2*l.*) have been taken out. There being little water, the dry process is used. Mexicans bring in gold from the vicinity of Gila city, 20 miles from Yuma, where placers have been worked for many years.

The vein-gold of Arizona is almost entirely found in the argentiferous lead ores, and the state is remarkable for its silver rather than its gold.

California.—The auriferous wealth of California may be divided into two sections—placer diggings and quartz veins. Of the former, the shallow portions are now nearly exhausted, and of very small importance, though the deep or high gravels, lying chiefly in Nevada, Placer, and Sierra counties, still continue to be worked on a grand scale; the quartz veins are scattered from San Diego to Plumas counties, the most important and productive being in Amador and Nevada, and on or near the "Mother lode" or "great quartz vein," an irregular, disjointed outburst of quartz, extending over a distance of 80 miles, from Mariposa to Amador, in a series of lenticular masses, separated by barren intervals.

Amador county.—The mother lode, occupying a width of about 12 miles, passes through the centre of this county, the principal mining towns being Jackson, Sutter, Amador, and Drytown. Some of the chief mines are worked on intermittent outbursts of quartz between Jackson and Drytown. The Oneida mine, 2 miles north of Jackson, has a vein 8 ft. wide, with the usual strike and dip, the quartz yielding $10 to $11 (2*l.* to 2*l.* 5*s.*) a ton. In Hayward's mine (formerly Eureka and Badger mines), the vein runs N. 22° W., dipping 70° E., and enclosed in dark, soft, argillaceous slate. The width of the vein varies from 8 to 40 ft., and after a length of 500 ft. suddenly pinches out. The gold is very regularly diffused in the mineral, but rarely visible. The free gold usually runs $15 (3*l.*) to the ton, besides 3 per cent. of auriferous pyrites.

Several quartz mines are working at Volcano, some affording a good yield of gold. The Whitman vein is in a band of slate lying between granite; it can be traced for 2 miles, with a general direction of N. 22° E., and a dip of 65° E., its average width being 6 ft. In the same band, the Italian's vein has an opposite dip, is about 5 ft. wide, runs N. 40° E., and dips 45° E.; and the Leviathan ranges from 9 to 25 ft. wide, yielding

$10 to $70 (*2l.* to *14l.*) a ton. There is a considerable quantity of gold in the detrital mass overlying the auriferous slates in this region.

Butte county.—In 1860, this county had 29 quartz mills, and 64 mining ditches, with an aggregate length of 583 miles; in 1875, there were only 10 mills (2 running), and 330 miles of mining ditch, supplying 8000 in. of water. About 4000 to 5000 tons of quartz were crushed in 1875. The sources of water-supply for the chief mine, at Cherokee Flat, are Butte Creek and the branches of the Feather River, as well as the watershed of Table Mountain. The tailings from the mines have run down the channel of Dry Creek. The Spring Valley Company here received $401,600 (80,320*l.*) for gold bars in 1874-5. The Cherokee mines yield also platinum and diamonds. The two leading veins are described as follows:—

Forbestown Consolidated: course, S.W. and N.E.; dip, N.W.; average width, 6 ft.; country-rock, slate; vein-matter, quartz; stamps, 10; weight, 750 lb.; drops per minute, 85; height, 6 in.; process, Paul's; capacity per day, 10 tons; cost of treatment, $2 50c. (10*s.* 5*d.*).

Mammoth: course, E. and W.; average width, 6 ft.; country-rock, granite; vein-matter, quartz; stamps, 5; weight, 650 lb.; drops per minute, 85; height, 7 in.; process, Paul's; capacity per day, 10 tons; cost of treatment, $1 50c. (6*s.* 3*d.*).

Calaveras county.—From the foot-hills bordering the San Joaquin Valley towards the summit of the Sierra, runs the belt of auriferous metamorphic rocks which forms the great mining field of central California. The lower portion is only covered by superficial detritus, apparently remnants of broken channels, which existed higher up, and flowed in a general direction from north to south. In the higher portion, near the junction of the slates and granite, are isolated patches of these ancient gravels, covered by basaltic lava, and below these, on the limestone belt, superficial placers which are worked during the rainy season. The mother lode enters the county from Tuolumne, and crosses it into Amador. It makes strong croppings at Carson Hill, Albany Hill, Angel's, San Andreas, and Lower Rich Gulch, on the Mokelumne River. Carson Hill alone is credited with the production of $4,000,000 (800,000*l.*) of gold, but operations have been suspended for some years, as the free-gold bearing character of the rock changed in depth, and was succeeded by tellurides and arsenical compounds requiring metallurgical treatment. In 1875, there were 40 quartz mills, 30,500 tons crushed, 23 mining ditches, 510 miles in length, and delivering 3160 miners' in. per diem; in 1870, 24 mills, crushing 11,536 tons, 22 mining ditches, 598 miles long, and giving 6300 in.

El Dorado county.—The belt of auriferous rocks in this county is nearly 30 miles wide, and contains several systems of quartz veins, among them being the mother lode; but the formation is much broken, and the ore of low grade. During 1875, only 3 mills out of 27 were at work; this falling off is attributable to the impoverishment of the quartz in depth. Several of the mines formerly noted for their production of free gold, such as the Cederberg, suspended operations, this class of ore running out at a depth of about 250 ft., and the quartz below that level being too poor for remunerative working. The leading mines are:—

Woodside: course, N.W. and S.E.; dip, 65° E.; average width, 3 ft.; country-rock, talcose slate; vein-matter, auriferous quartz; tons worked, 1500; average yield, $35 (7*l.*); percentage of sulphurets, 1½; product, 1875, $35,000 (7000*l.*); stamps, 5; weight, 650 lb.; drop, 7 in.; drops per minute, 84; cost of treatment, $2 (8*s.* 4*d.*).

Taylor: course, N.W. and S.E.; dip, 75° E.; country-rock, slate; vein-matter, auriferous quartz; tons worked, 5000; average yield, $7 to $18 (1*l.* 9*s.* 2*d.* to 3*l.* 15*s.*); percentage of sulphurets, 1; product, 1875, $50,000 (1000*l.*); stamps, 10; weight, 700 lb.; drop, 7 in.; drops per minute, 80; cost of treatment, $2 (8*s.* 4*d.*).

Mount Pleasant: course, N. 16° E.; dip, 80° E.; country-rock, granite; vein-matter, auriferous quartz; tons worked, 700; average yield, $47 (9*l.* 16*s.* 5*d.*); percentage of sulphurets, 1½; product, 1875, $31,000, (6200*l.*); stamps, 10; weight, 750 lb.; drop, 7 in.; drops per minute, 80; cost of treatment, $2 50 c. (10*s.* 5*d.*).

Mariposa county.—The principal source of gold in this county up to 1870 was the Mariposa estate. The course of the vein is N.E. and S.W., dipping 65° E.; the width varies from 1 to 7 ft.; and the country-rock in the 6 different mines is: (1) porphyritic greenstone and talcose slate; (2) porphyritic greenstone and micaceous slate; (3) greenstone and talcose slate; (4) black slate on both walls; (5) porphyry and slate; (6) granite. The vein-matter is sulphuretted quartz and free gold; the average value runs from $8 to $40 (1*l.* 12*s.* 10*d.* to 8*l.* 6*s.* 8*d.*) per ton. In 1875, the county had 20 quartz mills, and 7 mining ditches totalling 45 miles long; in 1870, 30 mills crushed 35,000 tons, and 10 mining ditches 66 miles long delivered 3500 miners' in. of water. There is thus a considerable falling off, which is in part attributable to litigation and unexplained financial difficulties.

Nevada county.—This county derives its importance both from the extent of its auriferous gravels and the number and richness of its quartz lodes. In 1870, there were 73 quartz mills, which crushed 125,000 tons, and 53 mining ditches, with a total length of 875 miles; in 1875, the mills were reduced to 46, and the quantity crushed to 80,000 tons, while the mining ditches numbered 75, with a total mileage of 625 miles, delivering 40,000 miners' in. per diem. The principal quartz-mining district is Grass Valley, where operations commenced in 1851. The aggregate product of its quartz veins was estimated by Raymond to have reached $30,000,000 (6,000,000*l.*) in 1875. The auriferous rocks are mostly metamorphic schists or greenstones, alternating with belts of syenite. The quartz veins are generally not large, 8 ft. being a full average thickness; while some of the most productive have not averaged over 1 ft. The metallic contents vary extremely; but the gold is easily saved, being clean, angular, and not very small. The sulphurets usually amount to 2 per cent. of the auriferous rock; they are readily concentrated, and yield an average of $100 (20*l.*) a ton nett by the chlorination process. The district contains about a dozen continuously productive mines, about half of which have given great profits, and as many more irregularly remunerative. The principal may be thus described:—

Idaho: course, N.W.; dip, 70° S.W.; average width, 7 ft.; country-rock, greenstone and slate; vein-matter, quartz; stamps, 35; weight, 850 lb.; drop, 10 in.; drops per minute, 70; capacity per day, 70 to 80 tons; cost of treatment, $2 (8*s.* 4*d.*); tons crushed in 1875, 28,103.

New York Hill: course, N.W.; dip, 35° N.E.; average width, 2 ft.; country-rock, greenstone; vein-matter, quartz; stamps, 19; weight, 900 lb.; drop, 9 in.; drops per minute, 80; capacity per day, 45 tons; cost of treatment, $2 25c. (9*s.* 4*d.*) per ton; tons crushed, 1875, 25,000.

Eureka: course, N.W.; dip, 70° S.W.; average width, 3 ft.; country-rock, greenstone and slate; vein-matter, quartz; stamps, 30; weight, 850 lb.; drop, 10 in.; drops per minute, 62; capacity per day, 60 tons; cost of treatment, $3 34c. (13*s.* 11*d.*) per ton; tons crushed in 1875, 4310.

Empire: course, N.; dip, 28° W.; average width, 1½ ft.; country-rock, greenstone and slate; vein-matter, quartz; stamps, 20; weight, 900 lb.; drop, 9 in.; drops per minute, 73; capacity per day, 40 tons; cost of treatment, $2 (8*s.* 4*d.*); tons crushed in 1875, 11,000.

Pittsburg: course, N.; dip, 74° W.; average width, 11 in.; country-rock, slate and granite; vein-matter, quartz.

Antelope: course, N.E.; dip, 40° N.W.; average width, 11 in.; country-rock, granite and greenstone; vein-matter, quartz and ochre.

California (*a*): course, N.; dip, 40° E.; average width, 1 ft.; country-rock, granite; vein-matter, clay-slate, &c.; stamps, 10; weight, 750 lb.; drop, 7 in.; drops per minute, 78; capacity per day, 18 tons; cost of treatment, $2 (8*s.* 4*d.*) a ton; tons crushed in 1875, 3940.

Gold Tunnel: course, N.; dip, 36° E.; average width, 1 ft. 2 in.; country-rock, granite; vein-matter, clay and quartz; stamps, 10; weight, 750 lb.; drop, 8 in.; drops per minute, 80; capacity per day, 18 tons; cost of treatment, $1 75c. (7*s.* 4*d.*) per ton; tons crushed in 1875, 1000.

Nevada: course, N.W.; dip, 45° N.E.; average width, 5 in.;

country-rock, granite; vein-matter, quartz with pyrites and galena; stamps, 15; weight, 750 lb.; drop, 9 in.; drops per minute, 85; capacity per day, 30 tons; cost of treatment, 75c. (3*s.* 2*d.*); tons crushed in 1875, 4000.

California (*b*): course, N.W.; dip, 45° N.E.; average width, 3 in.; country-rock, granite and slate; vein-matter, quartz; stamps, 10; weight, 750 lb.; drop, 7 in.; drops per minute, 78; capacity per day, 20 tons; cost of treatment, $2 (8*s.* 4*d.*); tons crushed in 1875, 2000.

Placer county.—This has been one of the most important hydraulicing counties in the state. The chief quartz-mining districts are in the vicinity of Auburn, in the foot-hills bordering on the Sacramento Valley. Their description is as follows:—

St. Patrick: course, E. and W.; dip, 45° S.; thickness, 20 in.; country-rock, trap cap overlying granite; vein-matter, quartz; average value, $41 50c. (8*l.* 13*s.*) per ton; percentage of sulphurets, 2½.

Crater: course, E. and W.; dip, 43° S.; thickness, 20 in.; country-rock, syenite; vein-matter, quartz; average value, $42 (8*l.* 15*s.* 1*d.*) per ton; percentage of sulphurets, 3.

Spanish: course, N. and S.; dip, 38° E.; thickness, 36 in.; country-rock, metamorphic slate covering granite; vein-matter, quartz; average value, $9 (1*l.* 17*s.* 6*d.*) per ton; percentage of sulphurets, 2½.

Gold Blossom: course, N. and S.; dip, 78° E.; thickness, 30 in.; country-rock, metamorphic slate; vein-matter, quartz; average value, $7 50c. (1*l.* 11*s.* 3*d.*) per ton; percentage of sulphurets, 1½.

Mina Rica: course, N. and S.; dip, 85° E.; thickness, 18 in.; country-rock, metamorphic slate; vein-matter, quartz; average value, $15 (3*l.* 2*s.* 6*d.*) per ton; percentage of sulphurets, 2½.

St. Lawrence: course, N. and S.; dip, 43° S.; thickness, 24 in.; country-rock, metamorphic slate; vein-matter, quartz; average value, $7 50c. (1*l.* 11*s.* 3*d.*) per ton; percentage of sulphurets, 1½.

Buckeye: course, E. and W.; dip, 65° S.; thickness, 15 in.; country-rock, metamorphic slate; vein-matter, quartz; average value, $32 50c. (6*l.* 15*s.* 5*d.*) per ton; percentage of sulphurets, 2.

Elizabeth: course, E. and W.; dip, 58° S.; thickness, 20 in.; country-rock, metamorphic slate; vein-matter, quartz; average value, $28 (5*l.* 16*s.* 8*d.*) per ton; percentage of sulphurets, 2.

Cooper: course, E. and W.; dip, 45° S.; thickness, 20 in.; country-rock, metamorphic slate; vein-matter, quartz; average value, $22 (4*l.* 11*s.* 8*d.*) per ton; percentage of sulphurets, 2½.

Scott: course, E. and W.; dip, 80° S.; thickness, 8 in.; country-rock, syenite; vein-matter, quartz; average value, $20 (4*l.*) per ton; percentage of sulphurets, 1.

Holder: course, E. and W.; dip, 80° S.; thickness, 8 in.; country-rock, syenite; vein-matter, quartz; average value, $30 (6*l.*) per ton; percentage of sulphurets, 1½.

Shady Side: course, E. and W.; dip, 80° S.; thickness, 8 in.; country-rock, syenite; vein-matter, quartz; average value, $50 (10*l.*) per ton; percentage of sulphurets, 1.

Auburn: course, N. and S.; dip, 45° E.; thickness, 30 in.; country-rock, metamorphic slate; vein-matter, quartz; average value, $15 (3*l.*) per ton; percentage of sulphurets, 1.

Solsie: course, N. and S.; dip, 45° E.; thickness, 12 in.; country-rock, metamorphic slate; vein-matter, quartz; average value, $40 (8*l.*) per ton; percentage of sulphurets, ½.

Consolidated: course, E. and W.; dip, 32° S.; thickness, 20 in.; country-rock, metamorphic slate; vein-matter, quartz; average value, $10 (2*l.*) per ton; percentage of sulphurets, 1.

Orleans: course, E. and W.; dip, 45° S.; thickness, 36 in.; country-rock, metamorphic slate; vein-matter, quartz; average value, $15 (3*l.*) per ton; percentage of sulphurets, 8.

Crandall: course, E. and W.; dip, 45° S.; thickness, 36 in.; country-rock, metamorphic slate; vein-matter, quartz; average value, $8 (33*s.* 4*d.*) per ton; percentage of sulphurets, 4.

Julian: course, N. and S.; dip, 60° E.; thickness, 36 in.; country-rock, syenite; vein-matter, quartz; average value, $8 (33*s.* 4*d.*) per ton; percentage of sulphurets, 2½.

Plumas county.—Little gold, except what has been derived from the overlying gravel, is found in the beds of the streams coursing through the great syenitic mass of the Spanish Peak range. The most productive zone is within the group of slates situated between the syenite and the belt of greenstone, particularly in the talcose slates. This condition holds good in the south-west, at or near the junction of the slates with syenite, granite, and serpentine. Gold occurs in the recent alluvium originating in the greenstone belt, or *in situ* in this rock. The next slate group adjoining the serpentine shows but few original gold-deposits.

Within the great serpentine belt, no gold is known occurring in place, and but little in alluvial beds that cannot be traced to the older gravel deposits situated upon it. The slate group east of the serpentines appears to be auriferous to some extent, particularly near the edge of the sandstone schist, which latter gives evidence of having originated many auriferous deposits.

San Diego county.—The mines of this county are mainly situated in Julian and Banner districts in the Santa Isabella Mountain, some 40 to 60 miles north-east of San Diego town. The main mass of the Cuyamac portion of the mountain consists of mica-slate and hornblendic porphyry, coursing north-east and south-west, standing almost vertical, and bounded westward by basaltic rocks, which have overflowed its western boundary of garnet porphyry. The veins are very numerous, lie on the western and south-western slopes of the mountain, and run in almost every conceivable direction, subject to the irregularities of the hornblendic porphyry. The larger veins course north-east and south-west, and are imbedded in the slate. Their dip is from 70° E. to almost vertical. They are narrow, and have no bold outcrop, and only in places are clearly-defined walls laid open. The gangue is quartz, and varies in width from ½ to 3 ft. Gold is the only precious metal which the veins carry; accompanying it are traces of antimonblende. The gold occurs in grains and thin flakes, and is about 790 fine. It is disseminated very sparingly in the gangue, but occurs in rich pockets at intervals. The veins are expected to last in depth; but they are narrow, and demand economical management. There were 8 quartz mills at work in the county in 1875. A few of the mines yielded $20 to $30 (4*l.* to 6*l.*) per ton.

Tuolumne county.—This county has been made remarkable by the deep-lead mining under Table Mountain. In 1875, 20 quartz mills were at work, crushing about 15,000 tons. The chief mines are:—

Golden Gate: course, N.E. and S.W.; dip, 70° to 80° W.; average width, 6 ft.; country-rock, slate; vein-matter, flinty quartz; average yield, $14 50c. (3*l.* 0*s.* 5*d.*) per ton; percentage of sulphurets, 1½ to 4.

Confidence: course, N. 25° W.; dip, 22° E.; average width, 7 ft.; country-rock, granite; vein-matter, quartz and sulphurets; average yield, $16 (3*l.* 6*s.* 8*d.*) per ton.

Yuba county.—The placer mines of Sucker Flat, Smartsville, and Timbuctoo have been among the most productive of the state. In respect to quartz mining, the county has a poor record.

Gold-gravels of the Sierra Nevada.—The preceding remarks under the heads of the counties of California have referred more especially to the quartz reefs and their products; but the state is more remarkable for its abnormally developed system of deep placer mines. These have recently been made the subject of most elaborate and exhaustive research by the well-known geologist, Professor J. D. Whitney, from whose magnificent work—'The Auriferous Gravels of the Sierra Nevada'—the following notes have been condensed.

Distribution of the Gravels.

In the Pliocene gravels, which, at the mouth of the San Francisco Cañon, lie unconformably on the older rocks, gold has been obtained by washing at various times since 1841. In the Sierra Nevada, the formations which overlie the bed-rock are of greater interest than in perhaps any other mountain chain. They are often of great thickness, as compared with the usual development of such detrital beds ; they represent in their formation a geological period of considerable length, not being exclusively of recent or post-tertiary origin ; they are quite largely made up of volcanic materials, so that the period during which they were accumulating must have been one of great igneous activity ; and, finally, they are, almost everywhere, more or less auriferous, containing a sufficient quantity of gold to make their working profitable.

The most easily recognised division of the bed-rock is into granitic and metamorphic, for there is little of the non-granitic which has not undergone considerable chemical change. So large a portion of this metamorphic rock has a slaty structure, that the whole series is often termed the "auriferous slate series," or the "auriferous slates ;" not that the whole formation is gold-bearing, but that these are the rocks with which gold is associated, the metal, however, occurring almost exclusively—so far as the bed-rock is concerned—in connection with veins of quartz, which are abundantly distributed through certain portions. When, therefore, "bed-rock slates" or auriferous slates" are mentioned, unless with some special limitation, they include all the non-granitic rocks of the gold-region of the Sierra Nevada, underlying the imperfectly consolidated detrital materials, which, with the accompanying volcanic deposits, form the superficial covering of so large a portion of the western slope.

The highly metamorphic condition of many of these rocks, the fact that the gold-bearing formations of the Appalachian chain, of the Urals, and of Australia, has been proved to be of Palæozoic age, Murchison's dictum that gold could only be expected in any considerable quantity in the oldest rocks, and the entire absence of fossil evidence as to the epoch of the auriferous belt of the Sierra Nevada, long impressed geologists with the belief that this formation could not be otherwise than Palæozoic. [This point will be further discussed in the next chapter.]

The dolomitic or magnesitic portion of the great mother lode before mentioned (p. 129) decomposes somewhat readily, and it becomes a kind of "gossan," or cellular, ferruginous mass, of a dark-brown colour, often traversed in every direction by seams of white quartz. The quartz is the auriferous portion of the lode, although it is far from being uniformly impregnated with gold. Most of the mines which have been worked, between the Merced and the Stanislaus, are on the north-east side of the vein, either in contact with it, or in some parallel band of quartz subordinate to, or at a little distance from it. The talcose slate bands in the vein are often themselves more or less auriferous.

Gravel deposits of considerable magnitude are not limited, even on the Pacific slope, to the Sierra Nevada : there are quite extensive beds in the Coast Ranges. They have even, in one district, been worked to some extent for gold. Generally, however, they are not sufficiently auriferous to encourage working. Neither have the Coast Range gravel deposits those peculiar features which make the Sierra gravels so interesting. There are also gravel beds of considerable magnitude in the extreme southern and northern portions of the State of California, which are more or less auriferous, but in regard to which there exists little or no definite information. The gravels in the cañons of the San Gabriel Range, and in some of the valleys of the San Bernardino Mountain are, or have been, worked for gold at various times during the winter season. They are not the scene of extensive and permanent mining operations, but rather of the nature of the ordinary placer-mining gravels; i. e., of local origin and comparatively unimportant. The deep cañons of the rivers of the extreme northern counties, especially the Klamath and its branches, contain large amounts of gravel, which have been at times extensively worked for gold, and in places with large profits.

The gravel region proper, or that portion of the western slope of the Sierra Nevada here to be especially described, may be said to be nearly conterminous with the belt of auriferous slates. Where granitic rocks prevail, whether in the southern portion of the Sierra, or along the crest of the range, the gravels are local in character and not largely washed for gold. The true gravel-mining region begins in Mariposa county and extends into Plumas, as far as the line marking the limit beyond which the slope of the Sierra is entirely covered with volcanic material. But all portions are by no means equally important, either in respect to the amount or the richness of their gravel. Taking the counties in geographical order from south to north, the importance of the gravel deposits increases from Tuolumne to Calaveras, and thence to Amador; El Dorado, Placer, Nevada, and Sierra are the great mining counties, and there is a gradual falling off in Butte and Plumas.

These gravels are worked by the hydraulic method described in detail in a subsequent chapter. Tunnel mining is practised on a much less extensive scale than formerly.

Origin of the Gravels.

The whole series of phenomena observed in the Sierra Nevada gives ample grounds for the belief that the metamorphic rocks of the range,—the bed-rock in fact,—were the original home of the gold now so generally distributed through the gravel. Obviously the mode of occurrence of the auriferous gravels themselves shows clearly that their presence is entirely dependent on that of a body of slaty rocks, enclosing great numbers of quartz veins, which in many cases are sufficiently well supplied with gold to repay the expense of mining. In short, the quartz-mining districts and the gravel region are essentially one and the same tract of country, as will be apparent on inspection of the various maps accompanying Whitney's splendid volume.

Some very fine gold has been carried, no doubt, to a considerable distance from its native bed, and deposited upon strata which were not in the least auriferous; but the coarser portion of the gold remains either on or in close proximity to the place where it originated.

That the distribution of the gold in the gravel should be irregular, and that it should be wide-spread, are conditions which seem quite in harmony with its origin. Quartz veins are very generally distributed through the bed-rock series; a large portion of these contain some gold, many of them are rich enough—in places, at least—to pay for working. But it appears to Professor Whitney very clear that the older gravels have been formed from a material considerably richer in gold on the average than is the present bed-rock of the region.

As to the question whence came the gold contained in the quartz veins, Whitney would derive it from the enclosing and surrounding rocks themselves. There are abundant facts to prove beyond all doubt that gold is distributed in minute quantities far and wide throughout the great mass of these metamorphic rocks, entirely independent of all the quartz veins. Indeed, it may well be questioned whether there is so much as a single ton of metamorphic rock of the auriferous series above the level of the sea in the Sierra Nevada in which a sufficiently delicate chemical analysis might not detect a trace of gold; and it can hardly admit of a doubt that the aggregate quantity of the gold which is thus distributed through the mass of the rock is incomparably greater than that which exists in the quartz itself. There is thus no lack of resource from which the gold in the quartz may have easily been derived; while, on the other hand, the general character of the quartz veins themselves appears to him to furnish strong evidence in favour of the view that the gold in them has been thus derived. They are not often what are technically called "fissure veins." They are generally intercalated between the planes of stratification of the slates, and irregular bunches and lenticular masses of limited extent are common among them. Furthermore, the rocks in many localities are penetrated in every direction by little irregular quartz veinlets and stringers, which often carry gold, and are sometimes in spots extremely rich, even when less than an inch in thickness.

Throughout the gravel region, the evidence constantly presented is cumulative and overwhelming that these gravel banks are the work of streams of fresh and running water. But then arise the great questions, Whence came these streams, and where did they go? In answer thereto, the theory which first gained extensive credence was that of the former existence of a single great river, flowing south-easterly for hundreds of miles along what is now the south-western slope of the Sierra, and nearly parallel with the axis of the range, before the mountains were uplifted. And the supposed channel of this great stream, now filled with gravel, was called the "blue lead."

This theory was founded, of course, upon the supposed existence of a narrow belt of deep gravel banks, stretching across the country in a south-easterly direction. But later, when it came to be more generally understood that the deep-gravel banks were not all confined within so narrow a belt as this theory would require, the theory was modified far enough to admit the existence in the gravel period of two or three large rivers with their branches, the courses of the main streams, however, being still supposed to be nearly parallel, and the general direction of their flow to be south-easterly.

The first objection to this blue-lead theory lies in the fact that from the Middle Yuba to the Mokelumne River, including the best-known and most important gravel-mining region in the State, there is no well-defined belt or belts of deep gravel banks stretching N.W. and S.E., such as must necessarily underlie the very foundation of this theory.

The single fact of the non-existence of any such definite north-west and south-east belt or belts of deep gravel banks as have been supposed, though perhaps insufficient of itself to positively disprove the blue-lead theory, does nevertheless completely remove the very foundation on which it was built.

But there are other and more positive objections to it. Incidentally, Whitney mentions another important fact connected with this theory. The term "blue lead" derived its origin, in part at least, from the blue gravel, and there has always been an intimate association in ideas between the two, many even going so far as to believe that the blue gravel was characteristic everywhere of the blue lead, and was not found outside of it. But the fact is that the blue gravel is scattered here and there all over the gravel region, though its quantity is ordinarily the greatest where the banks are heaviest. It cannot be said to be characteristic of any particular channel or set of channels. And Whitney is thoroughly satisfied that the peculiar dark-bluish colour which gave rise to the name "blue gravel" is due, in the vast majority of cases at least, not to any original peculiarity in the character of the rocks from which the gravel was derived, nor to any peculiarity in special streams which once flowed in particular channels, but simply to local chemical action in the mass of the gravel itself subsequent to its deposition.

The south-western slope of the Sierra Nevada, at the commencement of the gravel period, was, in Whitney's opinion, a broad, gently undulating, and moderately hilly country, having in all probability exactly the same gentle average slope which exists to-day south-westerly towards the valley,—a slope which for great distances ranges from 100 to 130 ft.

to the mile,—and having at the same time its greater drainage basins, already marked out where they exist to-day, by the occasional ridges and spurs which traversed, sometimes for considerable distances, the rolling hilly country, though rarely rising so much as 1000 ft. above the general plane. High up towards the summit of the range, indeed, the country grew gradually rougher; and here was probably more or less of cañon and of precipice, though it is not at all likely that there was anything comparable in magnitude with many of the modern cañons.

There may possibly, indeed, have been among the peaks occasional gorges 2000 or 3000 ft. in depth; but it seems hardly possible that any such gorges then could have been continuous for many miles, and they were the results, in all probability, not so much of denudation or erosion, as of the original upheaving forces which built the range and raised the lofty peak.

Among these loftier summits, the streams which slowly gathered the ancient auriferous gravel took their rise. Thence they flowed south-westerly across the smoother sloping country, the larger streams draining respectively nearly the same regions as now, and in the same directions, and finding their way by the shortest practicable routes to the valley, which, however, may then have been a lake or sea.

This appears to Whitney to be the general outline of the manner and means by which the ancient auriferous gravel was slowly accumulated, its materials—i. e. its gold, as well as its boulders, pebbles, and sand—being derived from the bed-rock over which the streams ran, and from the quartz, &c., which it contained. The longer such a process continued, the more the streams would wander, the greater would be the quantity of gravel accumulated, and the greater the actual area over which it would be spread. He thinks this process continued until the advent of the volcanic era, when the enormous quantities of volcanic matter which were spread far and wide over the western slope of the Sierra, buried beneath their mass the previously accumulated gravel, as well as the rocks from which it was derived, and were the chief and direct cause of the final ending of that gravel period.

Size and Character of the Gold.

At Wiessler's claim, Iowa Hill, the gold near and upon the bed-rock is coarse, and worn into elongated and flattened grains; it is said to be worth $18 (3*l.* 15*s.*) per oz. That from the upper part of the bank is scaly, and exceedingly fine, or "flour gold," and is generally worth 50c. to 75c. (25*d.* to 37½*d.*) an oz. more than the coarse gold on the bed-rock.

At the Lebanon Tunnel, the channel has proved rich in coarse and rather scraggy gold. One lump is said to have weighed 10 oz., and another 42 oz.

At Nahor's claim, in Green Valley Gorge, the gold is rather coarse and smooth, and it seems generally to grow coarser as the ridge is ascended from Iowa Hill.

The gold from the tunnels about the head of Indian Cañon was usually very coarse. Some of the claims paid well, and occasional spots were found that were very rich.

The gold in Grizzly Cañon is said to be coarse, and generally rather smooth, although some of it was quite "scraggy."

At the Mountain Gate Tunnel, near Damascus, the gold is generally not very coarse, although it is sometimes so, a piece weighing 9 oz. having been found here. The coarser gold is generally well-rounded and smooth, the finer is often flaky or scraggy, and sometimes pieces of considerable size are found very scraggy, with more or less quartz adhering to them. The gold from the Cement Mill claim, at Damascus, is not so coarse as that from the Mountain Gate Tunnel, and is worth about $18 25c. (3*l.* 16*s.*) per oz.

At Sterrett's claim, in Sailor's Cañon, east of Canada Hill, some coarse gold is found on the bed-rock, and finer gold in the gravel above. The gold is well washed.

Nearly all the gold in Weske's claim, near Michigan Bluff, even when the pieces are quite large, is in thin, scaly, and tabular forms, which are generally pretty well waterworn and smooth.

In the Van Emmons claim, at Michigan Bluff, the gold in the quartz gravel is not in such thin tabular forms as at Weske's mine, but is thicker and rounder, and more water-worn; it is also duller and darker in colour, and is said to be worth $19 50c. (4*l.* 1*s.* 3*d.*) per oz. The gold from the quartz gravel at this locality is said to be worth a little more per ounce than that from the so-called "black gravel," which contains less quartz and more metamorphic rocks.

Ströbel, who has been for many years a purchaser of gold-dust at Michigan Bluff, states that the fine gold is always richer than the coarse. For example, if coarse gold from a given locality be worth $17 25c. (3*l.* 11*s.* 10*d.*), the fine gold from the same locality will be worth $18 (3*l.* 15*s.*) per oz.

The gold from El Dorado Hill, near Michigan Bluff, is generally well water-worn, and about as coarse as that from Weske's mine, but thicker and heavier, and often very black; it resembles that from the quartz gravel at Michigan Bluff.

At the Specimen claim, in Byrd's Valley, many handsome specimens have been obtained of crystallized gold.

Mad Cañon, near Byrd's Valley, is said to have been very rich in scraggy gold, furnishing many beautiful specimens, with foliated and tabular crystalline forms. Ladies Cañon also paid well, but yielded little fine gold, the metal being mostly in large pieces, or "slugs," very rough and scraggy, and often associated with quartz.

In the Paragon mine, at Bath, the gold now obtained is always fine, a piece worth as much as 5c. (2½*d.*) being very rarely seen. Yet the pay-streak is rich, and portions of it have yielded $5 (1*l.*) per car-load, the cars holding but little over a ton each. But Wheeler, one of the owners of this mine, states that, while working the front portion of the mine, and for a distance of 2400 or 2500 ft. back from the mouth of the tunnel, considerable coarse gold was found, and pieces worth $2 to $5 (8*s.* 4*d.* to 1*l.*) each were not uncommon. Absolutely no coarse gold at all has been found more than 2500 ft. back from the mouth of the tunnel.

In the New Jersey mine, at Forest Hill, the gold from the back channel is not worth so much as that from the front. That from the quartz boulders contains considerably more silver than that from the gravel.

At Smith's Point, between First and Second Brushy Cañons, a stratum worked by drifting some 40 or 50 ft. above the bed-rock was quite rich in rather coarse gold; while the gravel beneath it is far poorer, and the gold much finer. The gold here is generally fine and scaly, but the coarse gold is pretty well worn and heavy. Considerable "shot gold" is also obtained from points in this region.

The gold in Castle Hill, a short distance above Georgetown, is pretty coarse, well-rounded and heavy; it is often more or less covered with a kind of blackish incrustation.

At the Excelsior claim, near Placerville, the gravel was drifted at two different levels, once on the bed-rock, and then again at 20 ft. higher. The bed-rock gold is rather coarse, much of it being in pieces of 5c. (2½*d.*) to $20 (4*l.* 3*s.* 4*d.*) in value; it is also very smoothly rounded, and it averages about $19 10c. (3*l.* 19*s.* 7*d.*) per oz. in value. The gold from the upper streak is rather fine, not quite so well washed as that from the bed-rock, and is worth, on the average, $1 (4*s.* 2*d.*) more per oz. than that. This gold is said to contain but a mere trace of silver.

Seam Diggings.

At Illinois Cañon, near Georgetown, are so-called "seam diggings," which consist of decomposed bed-rock, filled with irregular seams of quartz containing gold. This ground has been worked by the hydraulic method, and is said to have paid a little less than wages, on the average, although as high as $40 (8*l.* 6*s.* 8*d.*) to the pan has been obtained.

At Georgia Slide, near Georgetown, seam diggings have been worked in the bed-rock for some 16 or 17 years, and have reached a depth of 175 ft. in the bed-rock, which is a rather soft, decomposed slate, generally more or less talcose, and full of decomposed crystals of pyrites; much of the slate itself contains fine gold.

Young's Dry Diggings are shallow surface excavations, covering 2 or 3 acres of sloping ground, on the south-western side of the ridge, which extends along the road from Georgetown to Spanish Dry Diggings. They are said to have paid well, whenever water could be obtained. It is stated that a little seam of quartz, some 20 ft. long, was once struck here, from which in a short time between $25,000 and $30,000 (5000*l.* to 6000*l.*) was taken. The bed-rock at this locality consists partly of rather soft slate and partly of very hard and tough metamorphic sandstone; the latter occurs, in places, in lenticular masses enclosed in the slates.

The Spanish Dry Diggings belong entirely to the class of "seam diggings," although the gulches in this vicinity are said to have been rich in the early days. There are two principal claims, the Grit and the Dam. The course of the main tunnels is very nearly north and south, and this appears to be the general course of the belt of rich ground. Immediately east of the Grit claim is a heavy mass of semi-serpentine, which appears to be the product of the metamorphism of a very fine-grained slate. The rocks in the mines are slates and sandstones, the latter very fine-grained; these rocks are filled with crystals of iron pyrites, and traversed by numerous small irregular seams of quartz. It is said that, in the Grit claim, the seams which have paid best run nearly north and south, and dip to the east at an angle of 45°, or thereabouts. These seams traverse the decomposed rock, and dip towards the serpentine; but it is stated that they do not pass into it. The Grit claim is said to have yielded not less than $300,000 (60,000*l.*). It was from this mine that the magnificent specimen of gold was taken which was on exhibition for some time in San Francisco, and which afterwards was taken to Paris. Its intrinsic value was estimated at $4000 (800*l.*), and it was entirely made up of fine reticulations of imperfect arborescent crystallizations. It is said that some $6000 or $8000 (1200*l.* to 1600*l.*) more was taken out from the same place in the immediate vicinity of this remarkable specimen. The Dam claim is said to have yielded $250,000 (50,000*l.*); and the seam diggings, within a mile of the town of Spanish Dry Diggings, have yielded fully $1,000,000 (200,000*l.*).

The small quartz seams in the Dam claim run in every possible direction, without regularity, and the gold is very far from being uniformly distributed through them; indeed, it occurs chiefly in "pockets," so that it is commonly said that a miner at these diggings either makes nothing or a fortune. It is stated that, whenever the quartz seams run into hard rock, they thin out or disappear altogether, and the gold almost invariably gives out.

Immediately opposite Spanish Dry Diggings, on the other side of the river, at a place known as Shenanigan Hill, is a spot where some work has been done, and where are also seam diggings resembling those just described. There are other claims of a similar character in this vicinity, and from one—the Short Handle—it is said that $60,000 (12,000*l.*) was taken from a seam only 20 or 25 ft. long, and worked to a depth of 30 ft.

In the range of hills immediately west and south-west of the village of Greenwood, and which rise to a height of 100 to 150 ft., are seam diggings of some extent, in the so-called Franklin and French claims. Here a piece of ground of an irregular shape has been worked out, covering an area of 1 or 2 acres in extent, and the maximum elevation of the banks is about 60 or 75 ft. The rocks exposed here are very fine-grained argillaceous slate and sandstones, and associated with these is a rock which was once a fine breccia or conglomerate, and which has since been so metamorphosed as almost to have lost its original character. There is also a porphyritic slate, which consists of a fine-grained silicious base, with large crystals of felspar scattered through it. These crystals are so large and so peculiarly distributed through the rock as to give it an appearance slightly suggestive of its being covered with hieroglyphics. For this reason, probably, it is known to the miners as "China rock." All these rocks have been irregularly and extensively decomposed, and are traversed in every direction by little seams of quartz, but they are not numerous. These seams are occasionally rich in gold; but, to use the mineral phrase, they are very "spotted." It is said that about $80,000 (16,000*l.*) has been taken from the French claim in 10 or 12 years' working. There are several other claims of a similar character in this vicinity; but none has paid so well as the French claim. In the early days of California, the gulches and ravines about here are said to have been quite remunerative; but water is not abundant in this region.

There are seam diggings between Johntown and Georgetown on the hill at the head of Crane's Gulch. They are in a slate rock, which is quite talcose in character, and considerably decomposed. The slates have the usual north-westerly strike, and nearly vertical dip, and are a good deal contorted. The seams of quartz are irregularly distributed through the slates, curving more or less, but on the whole following pretty nearly their stratification. The whole area of ground which has been worked here is not far from ¼ acre, and from the flume or tailing-sluice to the top of the bank at the highest point is about 75 ft. At one place, a bunch of quartz is exposed at a depth of about 40 ft. below the top of the bank, and is there nearly 3 ft. thick; but a few feet higher up it splits into 8 or 10 little irregular stringers, which extend branching upwards for a short distance, and then disappear, none of them reaching the surface of the rock. This is, indeed, the case with most of the quartz seams at this locality: they rarely extend to the surface. There has been a great deal of pyrites in the quartz as well as in the slates; but it is now decomposed and carried away. The quartz itself is considered of little value, and is not crushed, the gold being all obtained from the sluices, for which purpose the rock has to be blasted and broken with the hammer, and then washed with a 2-in. hydraulic jet.

Amount and Yield of Gravel worked.

At Wiessler's claim, Iowa Hill, in 1871, the body of ground worked had a length of 1200 ft. and width of 400 ft. approximately; the maximum height of the bank was 125 to 130 ft. Assuming an average of 1200 ft. in length by 350 ft. in width, and 60 ft. in depth, the amount of gravel washed away will be 933,333 cub. yd. The amount of gold taken out can only be guessed at. It has been variously stated at sums ranging from $500,000 to $2,000,000 (100,000*l.* to 400,000*l.*).

From the south-west corner of the ground owned by Wiessler at Iowa Hill, another large pit extends into the hill in a direction S. 30° E. magnetic, for a distance of 700 or 800 ft. with a maximum width of something over 200 ft., the height of the bank at the head of the pit ranging from 60 to 80 ft. The quantity of material removed from here was estimated at 200,000 cub. yd. The bed-rock was not reached, and the gravel immediately upon it is said to be too poor to pay for working. No information has been obtained by Whitney as to the amount of gold yielded by this work.

On the south-easterly side of the Iowa Hill Ridge, including the North Star and Sailors' Union claims, an area of about 1000 by 250 ft. has been worked off, with an average depth of 100 ft.; this gives as the total amount of ground wasted, about 1,000,000 cub. yd. In regard to the operations of the Sailors' Union mine, the following statement was taken by Whitney from the Company's books:—Ground worked, 580 ft. long by 160 ft. wide, and with an average depth of 116 ft.;

Gold taken from the bed-rock ...	$124,598 (25,957*l.*)
Gold from gravel above bed-rock ...	42,800 (8917*l.*)
Total	$167,398 (34,874*l.*)

This gives as the yield of the gravel, which equals in amount 398,700 cub. yd., the sum of 10·7c. (5·35*d.*) per cub. yd.

At the Morning Star mine, near Iowa Hill, there has been about ½ acre of the bed-rock stripped and cleaned, which is said to have yielded about $30,000 (6000*l.*) exclusive of the $40,000 (8000*l.*) which was taken from the crevice.

At King's Hill there have been 4 or 5 acres washed off to an average depth of 20 ft.

In the east pit at Elizabeth Hill, an area of 700 ft. by 200 ft. has been worked to an average depth of about 20 ft. In the middle pits at

Elizabeth Hill, an aggregate area of about 3 acres has been washed off, exposing banks whose heights range from 50 to 75 ft. In the south-west pit at Elizabeth Hill, there has been about an acre of ground washed off to an average depth of 75 ft.

About 800 ft. south of the Wisconsin Hill school-house, on both sides of a little branch of Refuge Cañon, hydraulic pits have been worked over an aggregate of 5 to 6 acres, exposing banks whose maximum height ranges from 60 to 75 ft.

In the claims worked by Vaughan, at Wisconsin Hill, about 12 acres of ground were washed off, in 5 years' work, to an average depth of 55 ft. The yield is estimated at about $30,000 (6000*l.*), which would give an average of about 34c. (17*d.*) per cub. yd.

It is stated that in one season's work, the sum of $10,000 (2000*l.*) was taken from the Lebanon Tunnel, at New York Cañon, and the total yield of the mine is estimated to have been $75,000 (15,000*l.*).

At the Clinton claim, in Grizzly Cañon, an area of 600 ft. by 100 ft. was sluiced off to a depth of 20 ft., yielding, it is said, $240,000 (48,000*l.*).

The main channel at Canada Hill is said to have yielded about $100,000 (20,000*l.*), and the adjacent gulches $50,000 (10,000*l.*) more.

The English claim and the one adjoining it on the western side of the ridge, near Deadwood, are said to have yielded $100,000 (20,000*l.*).

The Morning Star mine, Startown, has yielded $300,000 (60,000*l.*).

The Slab claim, on the trail ¾ mile below Last Chance, is said to have yielded not less than $75,000 (15,000*l.*).

The Basin claim at the Devil's Basin is said to have yielded about $200,000 (40,000*l.*).

The Dick and the Arkansas claims are said to have yielded over $70,000 (14,000*l.*) each, and the Dam claim some $40,000 (8000*l.*). All three of these claims are on the upper part of the West Fork of El Dorado Cañon, 5 or 6 miles a little east of north from Michigan Bluff.

At Weske's mine, near Michigan Bluff, on June 16th, 1871, Goodyear saw washed out from 8 car-loads of gravel, of about 14 cub. ft. each, the result of one day's work, with 20 men employed, 91½ oz. of gold, worth $1601 25c. (333*l.* 11*s.* 10½*d.*). The total yield for the current week, at this claim, was 514½ oz., worth $8939 44c (1867*l.* 4*s.* 8*d.*). At this claim, the distance worked on the channel in 5 months was about 200 ft., and the yield during the first 5 days of the week of Goodyear's visit was 352 oz. Weske's mine had yielded something over $100,000 (20,000*l.*) up to June 30, 1871.

El Dorado Hill, near Michigan Bluff, is said to have yielded over $150,000 (30,000*l.*).

Fabulous stories are told of the richness of Dutch Gulch, which lies between the point of the Flat and Red Hill, at Michigan Bluff. For instance, it is said that one man took out $1100 (220*l.*) from a single pan of dirt here. Another statement with respect to the Flat itself, and which was repeatedly made, was to the effect that in drifting here two men took out 1200 oz. in one week; this was at the Empire claim. Stickner's Gulch, which runs down on the opposite side of the point, at Michigan Bluff, into Skunk Gulch, is also said to have been extremely rich, although not comparable with Dutch Gulch.

At Ayer's claim, on the east side of the ridge facing El Dorado Cañon, north of Michigan Bluff, from a space near the mouth of the tunnel, about 100 ft. long and 30 to 40 ft. wide, about $30,000 (6000*l.*) was taken out, and after that nothing further was found.

In the Franklin claim, near Michigan Bluff, from a triangular piece of ground about 80 ft. long and 40 ft. wide, or say 2000 sq. ft., $37,000 (7400*l.*) was taken out.

The Express Agent at Forest Hill, K. B. Soulé, stated that the shipment of gold through the Express office at that place in 1871 ranged a little over $30,000 (6000*l.*) per month; this comprises the yield of the Forest Hill, Brushy Cañon, and Yankee Jim claims. Soulé considered that the shipments from Michigan Bluff were a little greater in amount than those from Forest Hill, and that the total yield from the country between the North and Middle Forks of the American amounted (in 1871) to something like $1,500,000 (300,000*l.*) per annum.

At Smith's Point, between First and Second Brushy Cañons, a strip of ground 2000 ft. long and having an average width of 200 ft. approximately, has been washed off, with an average depth of 50 ft. It is estimated that more than a million dollars (200,000*l.*) has been taken from this ground. This was first drifted over, however, to a considerable extent, and afterwards "hydrauliced," and a portion of the gold was obtained from drifts running 200 to 600 ft. beyond the present faces of the banks.

Soulé stated that the yield of the Paragon mine, at Bath, had been, up to 1871, certainly over $750,000 (150,000*l.*), and that during 5 years, from 1865 to 1870, its regular product was $100,000 (20,000*l.*) per annum, no two years differing from each other by so much as $5000 (1000*l.*) during that time.

The area which has been hydrauliced off at Todd's Valley is probably about 1 mile long, with an average width of ¼ mile. The ground washed off here was in the form of a ridge, which, along the middle line, was some 60 to 75 ft. in width, and the average depth was about 35 ft. This gives a total amount of nearly 9,000,000 cub. yd., and the estimated yield from this ground is $4,000,000 (800,000*l.*), or about 44c. (1*s.* 10*d.*) per cub. yd. The estimate of the yield of this ground was given by Pond, who has lived at Todd's Valley since 1849, and is and has been largely interested in mining operations at that place.

A piece of ground in Pond's claim, of the yield of which precise record had been kept by Pond, and which was hydrauliced in the 5 years beginning with 1866, was surveyed by Goodyear. It was found to contain 138,206 sq. ft., or 3·1728 acres, equal to 15,356 sq. yd. If the pay-gravel averaged 35 ft. deep, as estimated, this will give 179,153 cub. yd. of auriferous gravel; and the total estimated depth of 50 ft. will give 255,933 cub. yd., in all, washed away from this ground. Its total yield was $91,828 30c. (19,130*l.* 17*s.* 11*d.*). Considering therefore the auriferous gravel alone, the yield would average 51·257c. (2*s.* 1·628*d.*) per cub. yd.; while, considering all the bank moved, it would be 35·88c. (1*s.* 5·94*d.*). Since the water bill for the same time was $29,003 42c. (6042*l.* 7*s.* 7*d.*), it also appears that the water cost about 11·332c. (5·666*d.*) per cub. yd. of earth moved. The price of the water was 10c. (5*d.*) per "inch" for 10 hours, or 1c. (½*d.*) per "inch" per hour. But the method of measuring the water was an unusual one. The opening in the measuring-box through which the water issued was 10 in. high, its bottom being level with the bottom of the box, and the water standing 4 in. above the top of the opening, or 14 in. deep. The amount of the discharge was regulated by a sliding gate, which varied the horizontal length of the opening according to the quantity of water required. For example, if 400 "inches" were required, the gate was set to leave the opening 40 in. long.

The former Express Agent at Georgetown stated that Mameluke Hill had yielded not less than $2,000,000 (400,000*l.*).

The Roanoke Channel at Bottle Hill, near Georgetown, was found to pay well wherever there was any gravel, and many spots were extremely rich. From a single candle-box full of dirt as much as 70 oz. are said to have been taken. The total yield of the channel has been, it is thought, not less than $1,000,000 (200,000*l.*). Almost all the ground has been worked over three times, and a part of it four times, each time paying satisfactorily. In the first spur reached by the channel after crossing Roanoke Gulch, a spot about 100 ft. long, in the Buffalo claim, yielded, it is stated, about $60,000 (12,000*l.*). In the Bottle Hill claim, immediately below the last bend in the channel, before it passes out of the hill, was a spot about 200 ft. long, where the whole width of the channel did not exceed 75 ft., but which yielded as much as $200,000 (40,000*l.*), which would be over $13 (2*l.* 14*s.* 6*d.*) per sq. ft. of surface of the bed-rock. In this claim, it is said that there was in 1851 or 1852 a face of gravel 5 or 6 ft. in thickness, stretching entirely across the channel, and, to use the miner's expression, "perfectly yellow" with gold. Yet, rich as this gravel was, it has not generally paid expenses to hydraulic the top off, after the bottom had been drifted out. In all the spurs crossed by the channel, after leaving Roanoke Gulch, the cement is decomposed and soft, and easily piped, and the banks would not anywhere be more than about 100 ft. in height, if the whole bed of this portion of the channel were hydrauliced. Consequently several pits have been opened, and the attempt made to wash the whole off; but as a whole, the work has not even paid "water-money."

At Wilcox's claim, on the North Fork of Long Cañon, the gold is distributed entirely through the gravel from top to bottom. It is both coarse and fine, and generally flaky. The bed-rock surface is not rich, and would hardly pay for drifting. About 2 acres have been washed off here, and $100,000 (20,000*l.*) obtained.

The proprietor of Flora's mine, west of Volcanoville, states that his gravel averages at least $2 (8*s.* 4*d.*) a car-load, and that his claim has yielded about $20,000 (4000*l.*).

At the Excelsior claim, near Placerville, about 20 acres of ground have been washed off, with an average thickness of 50 to 60 ft. of pay-gravel. The yield from this ground is estimated at over $5,000,000 (1,000,000*l.*), about half of which was taken out by drifting, and the other half by hydraulicing. The whole ridge has been drifted out at two different levels; first on the bed-rock, and then along a second pay-streak, which was about 20 ft. above this. The latter streak paid about $12 (2*l.* 10*s.*) per day to the hand employed. Alderson, the principal proprietor, estimates the yield of the Excelsior gravel at $1 (4*s.* 2*d.*) per cub. yd. of dirt washed away; this includes also the top, which is volcanic gravel.

It is estimated that the yield of the ground in Coon Hollow, near Placerville, has been at the rate of $5 (20*s.* 10*d.*) per cub. yd., and that the total amount obtained there is $5,000,000 (1,000,000*l.*).

Amount of Gravel still remaining.

The distance in a straight line from the outcropping bed-rock a little south-west of the Parker House at Iowa Hill, to the base of the first Sugar Loaf, is some 2300 or 2400 ft.; and within this distance, says Whitney, nothing but gravel is to be seen on the crest of the hill. The Oddfellows Hall is not far from midway between these two extremities, and the drifting never extended so far southward as this Hall. As good a rough estimate as can now be made of the total quantity of gravel originally existing, and capable of being hydrauliced, in this ridge, between the first Sugar Loaf and Independence Hill, would be ½ mile square, or 160 acres, with an average depth of 100 ft. over the whole of it. The little flat on which stands Independence Hill is about ¼ mile long, and it is covered, though not very deeply, with volcanic matter, and may possibly be yet hydrauliced. This estimate would give, in round numbers, about 26,000,000 cub. yd. of auriferous gravel in the Iowa Hill Ridge, between the first Sugar Loaf and Independence Hill. Of this quantity, it may be estimated that about 20,000,000 cub. yd. were concentrated in the deep channel which crosses the crest at Iowa Hill itself, and the remainder scattered along the sides of the ridge at various points, but chiefly along the south-eastern side, near Indian Cañon, and in the shallow patch which caps the ridge near the Catholic church, a little north-east of Iowa Hill. The total quantity already washed away when Whitney wrote (1879), was put by him at probably between 2,000,000 and 3,000,000 cub. yd., of which about nine-tenths may be assumed as having come from the deep channel, and the remainder from smaller pits at other points. This would leave between 23,000,000 and 24,000,000 cub. yd. yet capable of being hydrauliced. How much of this it will ever pay to wash, is a difficult question to answer; but probably the greater portion of it will be worked with profit, whenever the supply of water shall be plentiful, reliable, and cheap. Such estimates as the above must, however, be considered only as approximations. In this case, the area was calculated from measurements made by pacing, the heights of the banks being determined by the aid of the barometer. There was also as much information obtained as possible in regard to the probable lay of the bed-rock under the gravel, both from personal observations and from the statements of men who had worked in the various shafts and tunnels in the region.

Goodyear makes the following estimate of the amount of ground remaining to be worked by the hydraulic process, in the vicinity of Placerville:—

Locality.	Dimensions.	Cub. yd.
Hangtown Hill to Reservoir	2640 ft. × 1000 ft. × 75 ft.	7,333,333
Excelsior claim, Coon Hill	40 acres 135 ft. deep	8,712,000
Webber claim, Coon Hill	900 ft. × 1200 ft. × 100 ft.	4,000,000
Webber Hill	40 acres 75 ft. deep	4,840,000
Little Spanish Hill	20 acres 100 ft. deep	3,226,666
Big Spanish Hill	10 acres 100 ft. deep	1,613,333
Smith's Flat	1200 ft. × 200 ft. × 60 ft.	533,333
Clay Hill	3 acres 15 ft. deep	72,200
Indian Hill..	6 acres 20 ft. deep	193,600
Negro Hill, below Reservoir	50 acres 75 ft. deep	6,050,000
Steven's claim, spur	15 acres 40 ft. deep	968,000
White Rock Cañon, south-west side	1200 ft. × 1000 ft. × 40 ft.	177,778
White Rock Point, spur	1500 ft. × 400 ft. × 90 ft.	2,000,000
Cedar Flat	15 acres 45 ft. deep	1,089,000
	Total	40,809,243

If, to the above estimate, is added 25 per cent. for special localities, which is probably a liberal allowance for the quantity which remains distributed along the sides and spurs of various hills, and not taken into account above, it may be said, in Whitney's opinion, that as fair an estimate as can now be made for the total quantity of gravel capable of being hydrauliced in the vicinity of Placerville will amount, in round numbers, to 50,000,000 cub. yd.

Ocean placers or Beach diggings.—Klamath county is noted for its "gold bluffs," which extend into the neighbouring state of Oregon; they are auriferous sea-cliffs, which become disintegrated by the surf, and thus expose their gold. These beach sands are reported to have been prospected some 20 years ago; but though gold was discovered, it was not in quantity sufficient to pay the expense of working. Much attention has of late been directed to the subject of beach mining, and the discovery of gold in paying quantities seems now to be established beyond doubt. Since the discovery, the whole of the beach from north of the Ocean Side House, as far south as Point San Pedro, has been taken up by various claimants. Two of the claims are reported to have together taken out about $800 (160*l.*) for 2 weeks' work. As a discovery, it is probable that it is not a very rich find; but there seems to be sufficient gold to pay fair day wages. The pay per man has heretofore varied from $2 to $8 (8*s.* 4*d.* to 33*s.* 4*d.*), according to the statements of the miners.

The nature of the deposit, according to S. B. Christy, is very much what is usual in such cases. There are alternating layers of magnetic iron sand and of common quartz sand upon the higher parts of the beach, while lower down, where the surf breaks, the sand becomes usually coarser and more full of pebbles. Layers of black sand are not infrequently found upon the top of the partly dried, undisturbed sand, owing to the removal of the lighter siliceous material by the action of the wind. As one digs down, the layers alternate white and black, the thickness of each varying from that of a knife-edge to 3 and 6 in. At length, at a depth of 2 to 4 ft. the "hard-pan" is reached. This hard-pan is composed of a sort of clay sandstone; upon it is usually found a layer of coarser sand or gravel, which, especially when in depressions and crevices which favour a concentrating action of the waves, is usually the "best pay." But some of the higher layers of black sand are quite rich also. They seem to be formed upon a "false bottom," as the miners call it, by some high tide which makes a new deposit, while its waves are not violent enough to disturb the previous layers.

The concentrating action of the waves upon an inclined beach must be considerable. The configuration is entirely changed after a storm, and the whole area as far up as the cliffs is entirely covered by the surf during heavy weather. The action of the water on the sands is essentially the same as in the miner's pan. The quartz sand has a specific gravity of only 2·5, while that of the magnetic oxide of iron is usually about 5 ; hence the separation of these two materials is tolerably complete. The other heavy materials, as gold and platinum, naturally remain with the magnetic sand.

Under the microscope, the black sand shows itself to be composed of more or less perfectly rounded grains of magnetic oxide of iron, with a few silica particles, and occasional fragments of what appear to be garnets. Mixed with the black sand is the gold, which, under the microscope, is almost invariably bright, and in only a few cases presents a rusty appearance. It is always in the form of oblong or elliptical scales, which are doubly concave, and are usually surrounded by a thickened rim. A number measured by Clark gave the following dimensions :—

Largest	0·0065 in.	Smallest	0·0030 in.
	0·0060 ,,		0·0030 ,,
	0·0070 ,,		0·0035 ,,
			0·0035 ,,

Average thickness of the rims of the scales, 0·001 in.

Measurements made by Christy gave the following results :—

Gold .. .. 0·0108 in., 0·0098 in., 0·0049 in.

Platinum occurs also, though not in large quantities. The fragments are usually more compact and less flattened than the gold particles. One specimen measured 0·0044 in.

As the particles of magnetic oxide are very nearly of the average diameter of the gold particles, and as, moreover, they are rounded, it becomes a matter of the greatest difficulty to separate them by washing, in spite of their great difference of specific gravities, which are as 5 to 19. The leaf-like form of the gold renders it practically as easily moved by water as the magnetic oxide. It is only by the skilful touch of an old miner that a good "colour" can be shown in the pan.

The method of treating the ore, which varies from nothing up to $25 or $30 (5*l.* to 6*l.*), per ton, is to either pass it with water down an ordinary blanket sluice, or to use a combination of amalgamated copper plates, riffles, hanging plates, etc., such as the Russel amalgamator. Both these methods seem to work to the satisfaction of the parties interested.

Christy found that the gold amalgamates very freely, as one would naturally infer from its brightness and freedom from rust. The finer particles, when once allowed to dry, seem to become covered with a film of air, so that when again wet with water they float upon the surface. Another curious fact is the great purity of the gold. Falkner and Reese report the gold which they assayed as from 950 to 953 fine. The miners frequently treat their concentration before amalgamating with a little nitric acid to remove the iron rust (which does not seem to be present). It is not probable that this dissolves the silver from the gold, as these concentrations are still wet with salt water. It therefore appears to be more probable that the silver is removed by the long action of the salt water upon the thin scales, which are only a thousandth of an inch thick in their thickest part. However this may be, it is reported to be the purest placer-gold that has been found in California.

An estimation of the strata composing the bluffs has been made by A. W. Chase. Commencing at the top, the sections are: 10 ft. loam, 20 ft. yellow clay, 40 ft. coarse yellow gravel, 10 ft. brownish sandstone, 40 ft. red and yellow gravel, 5 ft. bluish sandstone containing partially lignitized trees, 55 ft. very coarse red and yellow gravel, 5 ft. very fine bluish gravel, 15 ft. indurated sand, 10 ft. deep red gravel, 5 ft. blue sandstone showing lignite, 5 ft. blue sandstone without lignite, 7 ft. gravelly beach to low-water mark; dip, 15° N. The fine gold is supposed by Chase to be mainly derived from the topmost stratum. The conclusions arrived at by him are as follows:—(1) That the gold evidently comes from the bluffs; (2) that after "caves," the gold obtained is much coarser in character; (3) that it is only after a succession of swells that cut the beach at an angle, that the rich sands are found: when the surf breaks squarely on, let the storm be never so heavy, it simply loads the beach with gravel; (4) that no one witnessing the power of the surf can doubt its immense grinding force; (5) that the gold follows the first two or three lines of breakers, and will never be found in paying quantities beyond.

Professor J. D. Dana, who examined specimens of the sand, says that the red grains in it are garnets, and that probably the deposit dates partly from the close of the glacial era (i. e. the time of melting of the ice in the early half of the Champlain period, when floods and gravel depositions were the order of the day), and partly from the later half of the Champlain period, when the floods had somewhat abated, and the depositions were more gentle.

Gold yield of California for 1880.—As "a specially trustworthy contribution to the history of the production of the precious metals of the United States," the *Mining Record* of New York gives (April 1, 1882) the appended table of "the gold product of California by counties for the 12 months ending May 31, 1880," to which is added the equivalent value in pounds sterling:—

COUNTIES.	Bullion produced from ore raised and treated during census year.			Production of hydraulic, placer, drift, and river mines for year ending May 31, 1880.			Total.	
	Gold.			Gold.				
	oz.	$	£	oz.	$	£	$	£
Amador	65,332 7	1,350,547	281,359	..	..	..	1,350,547	281,359
Butte	..	..	..	15,730 3	325,174	67,794	325,174	67,794
Calaveras	16,817 5	347,649	72,426	4,665 8	96,451	20,094	444,100	92,521
Del Norte	..	..	..	6,208 0	128,331	26,735	128,331	26,735
El Dorado	4,686 6	96,881	20,178	*24,877 7	*514,268	107,138	611,149	127,322
Fresno	3,355 3	69,360	14,450	..	..	..	69,360	14,450
Humboldt	..	..	..	3,724 9	77,001	16,096	77,001	16,096
Inyo	1,243 4	25,703	5,354	..	..	..	25,703	5,354
Lassen	1,680 5	34,739	7,238	..	..	..	34,739	7,238
Los Angelos	..	..	..	..	..	..	..	..
Mariposa	9,096 9	188,050	38,777	..	..	..	188,050	38,777
Mono	133,816 6	2,766,235	576,299	1,219 0	25,199	5,250	2,791,434	581,540
Nevada	43,000 9	888,907	185,188	2,062 3	42,631	8,881	931,538	194,071
Placer	2,902 5	60,000	12,500	13,998 2	289,368	60,285	349,368	72,840
Plumas	36,536 5	755,276	157,349	7,946 0	164,259	34,221	919,535	191,574
San Bernardino ..	..	..	..	..	..	..	..	..
Stanislaus	..	..	..	3,030 7	62,650	13,052	62,650	13,052
San Diego	11,506 0	237,850	49,552	..	..	..	237,850	49,552
Shasta	4,605 3	95,200	19,838	21,789 7	450,432	93,840	545,632	113,672
Siskiyou	9,834 0	203,204	42,339	23,413 1	483,992	100,831	687,196	143,165
Trinity	1,064 2	22,000	4,588	37,635 7	777,999	162,087	799,999	166,665
Tuolumne	6,204 5	128,260	26,721	27,081 7	*†559,828	116,626	688,088	143,352
Yuba..	..	..	..	*50,423 6	*1,042,349	217,155	1,042,349	217,155
Total	351,679 4	7,269,861	1,514,156	243,806 7	5,039,932	1,050,085	12,309,793	2,564,284
Additional production estimated from transportation statistics ..	50,790 1	*1,049,925	218,784	*171,298 3	*3,541,050	737,718	4,590,975	956,948
Grand total	402,469 5	8,319,786	1,732,940	415,105 0	8,580,982	1,787,803	16,900,768	3,521,232

* Estimated. † Including $300,000 (60,000*l.*) from "pocket" mines.

This estimate is at least $300,000 (60,000*l.*) below Wells Fargo's for 1879, and $850,000 (170,000*l.*) below that for 1880; and it is $600,000 (120,000*l.*) less than Burchard's figures for the year ending June 30, 1880, whence the editor of the *Mining Record* is "more satisfied than ever that the gold product is being over-stated."

Carolina (*North*).—Gold occurs in numerous localities throughout the state, generally in quartz veins of the gneissic, granitic and dioritic rocks, also in those of the talcose, chloritic and argillaceous slates; in beds of the slates themselves; and in the gravel deposits, the débris of the decomposed rocks and veins. The principal counties in which it has been found in sufficient quantity for exploration are: Franklin, Nash, Granville, Alamance, Chatham, Moore, Guilford, Davidson, Randolph, Montgomery, Stanly, Union, Cabarrus, Rowan, Mecklenburg, Lincoln, Gaston, Catawba, Caldwell, Burke, McDowell, Rutherford, Polk, Cleaveland, Cherokee, Jackson, Transylvania and Watanga.

It is generally more or less alloyed with silver, varying from pure gold on the one side to pure silver on the other. Near the surface, it is usually associated with limonite, and, at a greater depth of the deposits, with pyrite, chalcopyrite, galenite, zinc-blende, tetradymite, arsenopyrite, rarely with altaite and nagyagite. Specimens of gold, remarkable for their size, have been found at the Reed mine, in Cabarrus county, the Crump mine and the Swift Island mine in Montgomery county, (at the latter place in plates, covered with octahedral crystals,) at the Cansler and Shuford mine, in Gaston county, the Littlejohn mine, in Caldwell county, and Pax Hill, in Burke county. Very beautiful arborescent gold has been obtained from the Shemwell vein in Rutherford county. The variety "electrum," containing 36 to 40 per cent. of silver, has been met with in octahedral crystals at Ward's mine, in Davidson county; also in Union county, at the Pewter mine, and associated with galenite and zinc-blende at the Stewart and Lemmond mines, and in the neighbourhood of Gold Hill, Rowan county.

According to Dr. Asbury, very interesting specimens were found at Silver Hill, when the mine was first opened, consisting of lumps several inches in length, one end of which was pure gold, while the other was pure silver. None of them has been preserved.

Professor Emmons says that the gold of North Carolina belongs to four different geological periods:—(1) The loose quartz grits beneath the surface soil; (2) in stratified layers which are contemporaneous with the rock; (3) in connection with seams and joints of the rocks, and probably also diffused in the mass; (4) in regular veins associated with quartz and the sulphurets of iron and copper:—

(1) The quartz grits form loose beds, made up mainly of broken-down auriferous veins, in rounded and angular pieces, and resting usually upon a bed-rock, which may be of almost any formation. The origin of this auriferous grit is modern, and due in great part to existing forces. It is everywhere distributed in the state, but varies in thickness and richness.

(2) The occurrence of gold in layers and beds contemporaneous with the rock leads Emmons to pronounce it as "a sediment," and he traces it to "the Palæozoic period." These deposits may be "distinguished from veins by the absence of walls; there is really no line of demarcation between the auriferous layers and the adjacent ones." Even miners who are perfectly familiar with the bed "are not aware of a change, except by the absence of gold, or until it is proved by panning." These facts, in his opinion, "go to prove most conclusively that a fissure never was formed, and that the layer has become auriferous by the deposition of gold, in company with the sedimentary matter which forms the layer." It appears to him probable that the gold "may be widely diffused or contained in most of the rocks of North Carolina, which belong to the Taconic system" [the earliest member of the Palæozoic group, which he divides, in ascending scale, into Taconic, Silurian, Devonian, Carboniferous, and Permian]; but "it should be understood that the strata in which the quantity is sufficient to pay a profit are rare." The chief mines placed by Emmons in this class are:—Jones, Davidson county; Lafflin, Delft, Robins, Sawyer, Randolph county; Howie, Lawson, Union county.

(3) This class of deposits partakes both of the characters which belong to the sediments proper, described in (2), and of those in which the metal is distributed in regular veins. The gold of this class of deposit is connected immediately with quartz seams or irregular veins, which do not extend continuously through the rock, but terminate in it, and do not pursue the usual, nor any special, direction. The quartz is subordinate to slate, but Emmons is "not aware that the latter contains gold, except when it is in contact with the former, or is distributed in the natural joints, which usually contain a film of quartz. The distribution of the metal, too, is irregular;" it "is found in pockets or bunches, some of which are very productive." There is thus "more uncertainty in the results, and the mining operations cannot be conducted in a manner so systematic as when" the gold is "distributed in regular veins." In the Ward mine, of this class, the greatest quantity of gold has been obtained by washing the soil; the results obtained by panning on several acres show that gold is widely distributed in the immediate vicinity where the principal workings have been carried on. At the Cansler and Shuford mine, both the soil above the rock and the soft reddish rock itself yield the metal; but the most productive parts of the rock are the natural joints and quartz seams. In proximity to the natural joints, pieces of gold weighing 1 lb. have been found, made up of slightly coherent plates, separated by slate or talc. Other mines included in this class by Emmons are:—Hoover Hill, now being worked by an English company; Portis, Franklin county; Parker, Stanly county; and Beaver Dam, Montgomery county.

(4) True fissure veins need not be defined here. In North Carolina, their direction usually coincides very nearly with the strike of the beds; but it is rarely, if ever, that it continues to coincide with the beds as they descend with the rock. The extreme variation (in North Carolina) of the direction of the main or right-running veins is from N. 10° W. to N. 70° E., but it is usually N. 45° E. Veins intersecting this line should be considered only as cross-courses, but instances of them are not numerous in this state. The metal in a promising vein, in addition to its distribution in masses through the gangue, is also accumulated upon the foot-wall, and is rarely against the roof or hanging-wall. This is more obvious in the case of sulphurets than in quartz gangues. It is common in North Carolina for veins to extend a mile, and to carry sufficient metal to pay for working the whole distance. The principal mines enumerated by Emmons in this class are:—Conrad Hill, Davidson county; Gold Hill, Rymer, in Rowan county; Reed, Phœnix, Vanderburgh, Orchard, Barnhardt, Pioneer, all in Cabarrus county; Phifer, Davis, and Pewter, all in Union county; Hearne, Stanly county; Reynolds', Montgomery county; McCulloch, Fisher Hill, Lindsey, Beason, Harlan,

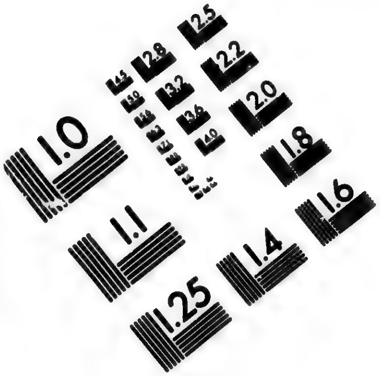
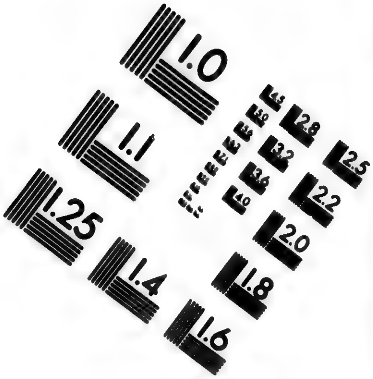
Gardner, all in Guilford county; Rudersill, Dunn, in Mecklenburg county.

Emmons concludes his remarks upon the gold of the state by deprecating the inefficiency of the apparatus employed in its extraction, and the carelessness and ignorance displayed in conducting operations.

Professor Kerr, the present State Geologist, endorses Emmons' remarks upon the ore beds described in (2), and says that the width of these auriferous beds varies from a few inches to 60 or 70 ft. The same authority is of opinion that all the auriferous gravels of the state have been formed by what he calls "frost drift" or "earth glaciers," i. e. the effects of repeated frost and thaw in decomposing the rocks, and then, by alternate expansion and contraction, causing their detritus to rearrange its component parts. According to Kerr, there are probably 500 square miles of gold-drifts in North Carolina. They are found through a range of 400 miles east and west, from the lower waters of the Roanoke, near Weldon, to the extreme western border, the county of Cherokee; and they belong to all the different subdivisions of the Archæan rocks of the state. The two most extensive deposits are found in the middle region on the Yadkin and Catawba rivers, among the low ranges and spurs of the mountains. The schistose and slaty rocks, highly inclined and much contorted and dislocated, are in many places penetrated by innumerable small veins and seams of gold-bearing quartz. In the disintegration and breaking-down of these rocks, and the movements of the débris in the manner described, it is evident that the gold particles, with the heavier crystalline minerals, will be accumulated near the bottom of the drifts, on or near the surface of the bed-rock, or "slate," as the miners call it.

The gold-mining of modern times began 60 years ago in this region, from the accidental discovery of a 28-lb. nugget by a boy in one of these streams. Most of the simple and effective appliances now in use everywhere for the separation of gold from such deposits—the long-tom, sluice, riffle-box, &c.—were devised and used in this locality, and were carried hence to California, when, 25 years later, the trained miners of this region emigrated in a body to that newer and richer field. Since that emigration, there has been but little placer mining done in North Carolina. Still this sort of mining has never entirely ceased, and in some sections, and by a few families, it has been followed continuously to the present. The richest deposits within reach of water have been worked over, but there are large areas still untouched, because inaccessible to water, without considerable outlay for ditching, canalling and fluming, to which, says Kerr, neither the capital nor the enterprise of the region is equal.

The gross gold-product of the mines of North Carolina, so far as indicated by the Mint returns, from 1838 to 1856, was $4,233,336 (881,945*l.*);

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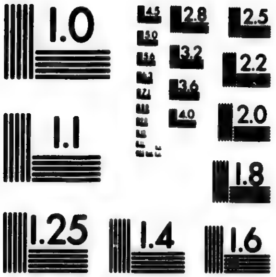

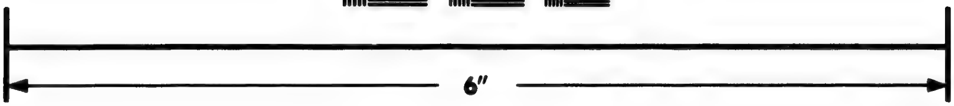

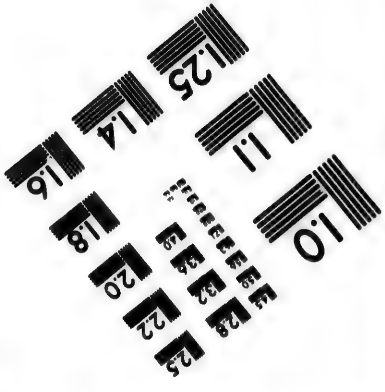

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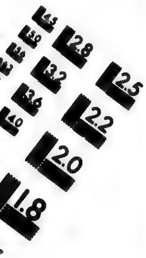
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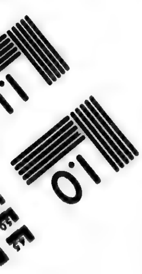
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Dr. Stevens (Amer. Jl. Min., i. 313) puts it at "not far from $30,000,000" (6,250,000*l.*) down to 1866. From a pamphlet accompanying a memorial from the Sixth Congressional District of North Carolina, asking for a commission to visit the district (Scien. Amer., xxxviii. 212), it appears that the gold-producing area of North Carolina covers about 12,000 sq. miles, containing 140 mines already (1878) developed, and that their gold-yield up to June 30, 1877, was $10,370,492 (2,161,074*l.*).

Carolina (South).—Here, according to Tuomey (1848), the gold-mines are of two classes, "deposit" or "branch" mines, and "vein" mines, fulfilling the same conditions as sections (2) and (4) of the North Carolina group. An example of the first-named kind in the Tomassic Valley covered an area of many acres; and on a branch of the Tyger is one extending a mile in length and having a width of 100 yd. At this locality, the auriferous gravel is 8 in. to 3 ft. thick, and is overlaid by a bed of pebbles 6 to 8 ft. thick, the whole occupying a flat between two hills, and being covered by a fertile soil of considerable depth; the deposit rests upon mica-slate, having a very irregular surface, and exhibiting unequivocal marks of the action of water.

As regards age, Tuomey considers that the deposit-mines may be referred to two distinct periods:—

(1) Those consisting of beds of rounded and waterworn quartz pebbles, of various sizes, but seldom exceeding 6 in. in diameter, constituting the most extensive beds in the State, and "in such positions as to preclude the possibility of the pebbles being rounded and transported by any stream or other aqueous force that could have existed since that region received its present form." The gold in these older deposits can "rarely if ever be traced to its original source in the veins in place, partly, no doubt, from their being transported from a great distance, and partly from the total destruction of the veins by denuding forces." In almost every mine of this class, there are peculiar indications known to the miners as favourable or otherwise: the presence of schorl, of ferruginous matter, etc. The deposits belonging to this category which are particularly mentioned by Tuomey are in the Tomassic Valley, on the Tyger, near the summit of the Blue Ridge, at the foot of Poor Mountain, and at Rankin's, on Little River.

(2) The beds of more recent origin are known by the angular fragments of quartz that predominate in them. Nearly all the vein-mines in the state have been discovered by tracing these beds to their sources. Not unfrequently the veins occur at a short distance from the deposit; but sometimes, while the soil contains sufficient gold to pay for working, when it is exhausted, not a trace of a vein can be seen, a circumstance ascribed by Tuomey to the fact of the original vein having thinned out and disappeared. This class of deposits embraces those

being worked in the vicinity of veins, such as at Estatoe, in Abbeville; on Lawson's Fork, in Spartanburg; and in Cherokee Valley.

The gold of the deposit-mines occurs in irregular particles, more or less water-worn, of larger size and greater purity than the vein-product.

The veins are also divided by Tuomey into two categories: (1) those in which the precious metal is found disseminated in the slates, or in beds between them, and called by the miners "slate mines"; and (2) those in which the lodes are true veins. In the former class, he includes, for the most part the mines of Chesterfield, Lancaster, and some of the Fair Forest mines, in Union. And to the latter belong Nott's mine, Nuckols and Norris's mine, those near the Limestone Springs, and those on the Broad River, near Smith's Ford.

In the King's Mountain range, the first mine towards the north on King's Creek is very remarkable, being a bed of rather poor iron ore (hematite) and common quartz, about 3 ft. thick, in mica-slate. The gold is confined to certain ferruginous portions, in which small quartz veins abound. At other places in this range, the gold is associated with iron as a yellow ochre. Above Easter-wood Shoals, some of the mines consist of talco-micaceous slates, intersected by veins of felspar passing into kaolin, the auriferous veins being coarse crystalline granite; at Littlejohn's, not far distant, on the contrary, the gold-bearing lodes are quartz, and though granite veins are common in the mine, they contain no gold. Tuomey is "convinced that all the oxide of iron that occurs in the gold-veins was once sulphuret of iron, or pyrites, and that at a depth below the surface which is quite variable, the iron associated with the gold exists in that form."

Colorado.—The principal gold-producing mines of Colorado are situated in Gilpin county, and are the subject of an exhaustive report by J. D. Hague, which will be largely drawn upon in the following remarks. Typical veins in this district will be selected for description, choosing those that have been most extensively worked.

Concerning the lodes in general, it may be said that they are all enclosed in a rock of one common type chiefly granitic, with gneissic varieties. Their course, with few exceptions, is either due E. and W., or N.E. and S.W., the prevailing line along the prominent lodes being about 5° to 10° N. of E. The Gregory, Bates, and a few others are exceptions; but the Bobtail, Burroughs, Gardner, Flack, Gunnell, Winnebago, and others, strike about N. 85° E., and more nearly represent the average course of the veins in the district. The dip is generally nearly vertical. The lodes possess the features of true fissure-veins, and are remarkably free from faults or displacements.

Bobtail lode.—This has the reputation of having been the most productive vein of Colorado. The average course for 800 ft. is due E.

and W.; the dip is nearly vertical, varying from N. to S.; the width of the vein ranges from a few inches or a mere seam to 10 or 15 ft., but does not exceed 3 to 4 ft. on an average. The enclosing rock is gneiss, sometimes of granitic character. The walls are usually well defined, especially the southern one. The vein matter is a quartzose and felspathic mixture, highly silicious, and carrying much free quartz, but not having the appearance of solid quartz veins; in many places, it has a granitic look, thus differing but little from the country-rock, and in such cases is usually quite barren. The gangue is soft, whitish or pale-greenish rock, consisting chiefly of decomposed felspathic material, mixed with quartz, and thickly impregnated with iron- and copper-pyrites. The richer ore is concentrated in a seam of solid sulphurets, composed mainly of iron and copper pyrites, with less quantities of galena, zinc-blende, arsenical pyrites, &c. The gold, rarely if ever entirely without silver, is associated with the pyrites, most richly with the fine copper-pyrites, and varying in the iron-pyrites according to the closeness of grain.

The productive part of the vein usually carries a seam of solid auriferous pyrites, 1 in. to 3 ft. wide, an average of 10 to 12 in. being deemed excellent; this seam is accompanied by a mass of gangue 1 to 4 ft. wide, with finely crystallized sulphurets generally disseminated through it. The last-named forms the bulk of the vein, and gives 6 to 7 oz. of retorted amalgam per cord (7 to 8 tons) of ore, the value being $14 to $16 (2*l.* 18*s.* 4*d.* to 3*l.* 6*s.* 8*d.*) a ton. The total yield of the lode since its discovery is roughly stated at $2,500,000 (500,000*l.*).

Gregory lode.—This lode is worked over a length of 1500 to 2000 ft., its general course being N.E. and S.W. The dip is nearly vertical, though sometimes N.W. and sometimes S.E. The country-rock is generally similar to that of the Bobtail, but sometimes abounding in mica. The walls are not very regular, and are liable in places to scale off and fall in large pieces. The width varies from 2 to 5 ft., sometimes expanding to 12 or 15. The vein-matter is like that of the Bobtail; the value of the compact ore seam is generally somewhat less, but its development is greater. The poorer matter gives 5 to 6 oz. per cord. Lumps of free gold worth $50 (10*l.*) have been found.

The yield of the lode can only be partially stated with regard to one portion of it: the Black Hawk mine in 1867 produced 12,193¾ oz. of crude bullion; in the latter half of 1868, 3942½ oz. of amalgam; in the first half of 1869, 3177 oz. of retorted amalgam.

Bates lode.—This lies nearly parallel to and several hundred feet north-west of the Gregory; it has been worked to considerable depth for about 1000 ft. in length. The country-rock has the same features as already described. The veins are somewhat less in width, but regular, well-defined, and promising as to permanence. The ores in some parts are distinguished by a large proportion of argentiferous galena, zinc-blende and silver sulphurets, associated with the iron- and copper-pyrites, giving them sometimes a high value in silver, but rendering difficult, or practically impossible by any simple process known in the district, the extraction of the gold.

Illinois lode.—The course of this lode is N. 60° E., with a gradual approximation to neighbouring lodes farther south, which run N. 85° E.; the dip is 84° S., and regular; the average width is about 2 ft.; and the walls are generally smooth and well-defined. The vein-matter is chiefly quartz; sometimes white, hard, and amorphous, carrying little or no metal; sometimes showing a sparse distribution of crystallized iron-pyrites throughout its mass. But most commonly the vein-matter is a mixture of siliceous and felspathic material, in which occur small seams or scattered particles of pyrites, associated, as before described, with a narrower but solid seam of compact pyritous ore; the latter is 2 to 12 in. thick. The valuable mineral in the mine consists chiefly of iron-pyrites, with a lesser proportion of copper-pyrites, and, as a characteristic feature, some arsenical pyrites; with these are associated zinc-blende and galena. The yield of this ore averages about 4 oz. of fine gold and 20 oz. of fine silver per ton. The yield of the poorer material averages about 1 oz.

Gardner lode.—This lode is nearly parallel to and 300 to 400 ft. north of the Illinois. Its course is N. 85° E., and dip 75° S., both being very regular. It has been partially developed over about 800 ft. in length. The vein is large and regular, seldom less than 3 or more than 10 to 12 ft. wide, the walls being smooth and well-defined, and costing little for timber. The ore resembles descriptions already given, but carries considerable galena and zinc-blende; and the valuable mineral is widely diffused. About ½ to ⅜ of all the vein-matter broken is sent through the stamps, and yields on an average about 6 oz. of bullion or $100 coin (20*l.* 16*s.* 8*d.*) per cord, equal to $12 or $14 (50*s.* to 58*s.* 4*d.*) per ton.

Burroughs lode.—One of the earliest discovered and most developed lodes in the territory, the Burroughs, lies about 400 ft. north of the Gardner, and almost exactly parallel. Its dip is nearly vertical, or 85° S. It is opened along more than 2000 ft., and worked to depths of 200 to 600 ft. The country-rock differs nothing from the preceding examples, but is narrower, varying from 8 in. to 4 ft. The vein-matter and ore present the same general features; but the pyrites is ferrous rather than cupreous, and more argentiferous than usual.

California, Indiana, Flack, Mercer County, and other lodes.—These are ½ mile west of the Burroughs lode which they resemble in position, but from which they differ widely in the character of the ore, carrying a much larger proportion of argentiferous galena, zinc-blende, and sulphurets of silver. Ores from some of these mines assay 7 oz. of gold and 68 oz.

of silver per ton; others, 3 oz. of gold and 18 oz. of silver. In the Coaley and Gilpin lodes, gold has quite disappeared, while the silver yield comes up to 215 oz. per ton.

With regard to the total gold-production of Colorado, Hollisted states that from 1859 to June 1866, $12,401,374 (2,583,624*l.*) worth was delivered to the mint; and supposing this to represent only one-third of what was actually got, the total would be $37,204,122 (7,750,872*l.*). Hague computed the output in 1868 and 1869 (combined) at $6,500,000 (1,354,166*l.*). Porter gives the total production in the census year (1880) as $3,200,000 (666,666*l.*), and enumerates the following counties:—Gilpin, $2,380,000 (495,833*l.*); Boulder, $300,000 (62,499*l.*); Clear Creek, $196,000 (40,833*l.*); Custer, $100,000 (20,833*l.*); Lake, $58,000 (12,083*l.*); Summit, $51,000 (10,624*l.*); Park, $50,000 (10,416*l.*); San Juan, $40,000 (8332*l.*); Chaffee, $31,500 (6565*l.*).

Dakota.—The auriferous region of Dakota is comprised within the Black Hills, and occupies a metamorphic range covering an area of 900 sq. miles, extending north and south through the central portions of the hills for a distance of 75 miles, with a breadth varying from 5 to 25 miles. The product, as estimated by the Director of the Mint, for 1880 was $3,600,000 (75,000*l.*) of gold.

The mineral resources of this region have been made the subject of a valuable report by W. P. Jenney, according to which the gold occurs in the following formations:—

I. In veins of quartz, more or less ferruginous, traversing the Archæan schists and slates.

II. In strata of slate, mineralized and altered by the action of waters depositing silica and iron-pyrites.

III. In the conglomerate forming the lower layer of the Potsdam sandstone, resulting in this case from the denudation of the ledges in the Archæan rocks.

IV. In trachyte and porphyry intruded at the time of elevation of the Hills, in the interval between the Cretaceous and Tertiary periods.

V. In deposits in the slates and sedimentary rocks, produced by the intrusion of the trachyte and porphyry.

VI. In placer-gravels resulting from the decomposition and erosion of the above formations, in Tertiary and recent times.

The miners, for convenience in making laws to govern the recording and locating of claims, have divided the gold-fields into different districts, which division is followed as closely as possible by Jenney in considering the value and character of the gold-deposits.

French Creek.—In the French Creek district is embraced all the area of granitic and schistose rocks surrounding Harney Peak, and forming the southern portion of the Hills, bounded by Spring Creek on the north, and including the placer-gravels in the valleys of Wiwi Creek, Custer Gulch or French Creek, Amphibious, Minnekata, and Red Cañon Creeks, streams draining the region and emptying into the south fork of the Cheyenne.

The gravel deposits elevated above the present level of French Creek show often a local concentration of gold on the outer edge of the bed-rock, from the repeated washing away of the gravel by floods or heavy rains, leaving behind the gold contained in it. Though giving a very encouraging prospect at first, on driving an open cut a few yards into the bar where the gravel was undisturbed, the richness of the pay-dirt rapidly decreased, until it equalled the true average of the whole deposit, showing that the result first obtained was only a rim-rock "prospect."

The richest layer in the pay-gravel was rarely on bed-rock, but usually 10 to 20 in. above it, forming the upper surface of the stratum of compact clayey gravel, mixed with fragments of decomposed bed-rock, which had caught and retained the greater portion of the gold.

The gold obtained from the placer-gravels on French Creek was in small flattened scales and grains, quite uniform in size, mixed with very little fine dust, and nearly free from magnetic iron sand. It showed but little action of water, and the garnet crystals associated with it were often quite perfect and scarcely rounded by attrition. The greater portion of the gold seems to be derived from the quartz ledges in the schistose rocks, and not from the intruded granite; for in side gulches, where the rocks are wholly composed of granite, Jenney failed to detect any traces of gold. The pay-gravel is composed of the heaviest pebbles, with some clayey sand and large quantities of red garnet crystals derived from the schists. It is soft, rarely cemented to a conglomerate, and easily washed in a sluice.

The exploration and prospecting on French Creek showed a general diffusion of fine gold in the gravel beds, but little concentrated in the deposits, and found in small quantities throughout the whole breadth of the valley.

Above the stockade are localities where the gravel will pay fair wages for sluicing, using the limited water-supply of the creek, and working only the richest places in the beds. Jenney regards the poverty of the French Creek deposits, compared with those afterwards discovered on the streams farther north, to be due to a deficiency in the source of supply, owing to the confined area drained by the stream, the small amount of denudation to which the ledges in this area have been subjected, and to a want of sufficient grade in the valley to cause a concentration of the gold into a pay-channel.

Had all the gold diffused through the valley of French Creek been concentrated into a narrow lead or pay-channel, it would have made claims as rich as the most enthusiastic miner could desire.

Spring Creek.—The result of Jenney's prospecting on Newton's Fork branch of Spring Creek seems to show a general diffusion of gold in nearly paying quantities through extensive gravel deposits, which in many respects resemble the bars in Custer Gulch. The water-supply was, however, considerably greater, and the grade or descent of the valley sufficient to enable the deposits to be worked with much less expenditure of time or labour; so that, were the deposits of equal richness, they would be more valuable here than on French Creek.

In the valley of Spring Creek, about 8 miles below Newton's Fork, near where the immense quartz formation known as the Mammoth ledge crosses the gulch, prospecting resulted in the discovery of gold in paying quantities in the placer-deposits of this stream.

On examination, the pay-gravel was found to be a deposit about 35 ft. in width, crossing the creek and extending into the banks on either side, resulting from the decomposition of a stratum of soft clay-slate in the bed-rock, which had caught and retained the gold swept over it by the stream. The "pay-streak" is a compact gravel, full of small red garnet crystals rich in coarse gold, 3 to 6 in. in depth.

The gold is derived from quartz ledges of enormous dimensions in a belt of clay-slate and quartzite, 20 miles in width, crossing the Hills in a north-westerly direction at this point. The clay from the bed of the stream near camp yields 4c. to 8c. (*2d.* to *4d.*) to the pan, and several pieces of about the value of a dollar have been found.

The richest layer in the deposit was the lower part of the red garnet gravel, where it rested on the upper surface of the blue plastic clay. Pieces taken from this contact showed, on breaking, scales and particles of gold contained in it. The bed-rock, so far as Jenney's party dug into it (about a foot below the surface), contained coarse gold in small quantities, probably caught in crevices in the rock before it decomposed.

This deposit may be described as a strip of plastic clay crossing the bed of the creek, and resulting from the decomposition of strata of soft clay-slate located on the rise of the bed-rock, while both above and below was a hard massive quartzite, smooth and water-worn, but protecting the slate from being rapidly cut away by the current of the stream. The sample obtained, when assayed, showed that the gold from this district is very pure, being $946\frac{4}{10}$ fine, or $22\frac{3}{4}$ carats; just as it is washed from the placers, it is worth $19 44c. to $19 63c. (*4l.* 1*s.* to *4l.* 1*s.* 9½*d.*) an oz.

The valley below the Mammoth ledge is contracted in width, and appears to have been gradually filled up since it was excavated.

Bed-rock has been reached in only two places, although a number of shafts have been sunk by the miners; and in these cases the rock was hard, and the gravel poor in gold.

Above the original discovery for nearly 5 miles, the gravel deposits are very broad and extensive; flats, in places ¼ mile wide, extend along the banks of the creek; while elevated bars are to be found at the bends of the stream and sides of the valley, which proved to be very valuable. Stand-off Bar pays $1 (4*s.* 2*d.*) in gold per hour per man employed.

The gold appears to be derived from the decomposition of the slates and quartzites, as well as from the denudation of the quartz ledges traversing these rocks. The source of supply of the gold is immense. The side valleys and gulches are often excavated for miles along the outcrops of the gold-bearing slates; and the quartzites, with their enclosed veins, have acted as feeders to the placers of the main valley. Over a very extensive area these rocks have been enormously eroded, and the resulting material swept away. The gold it originally contained has been partly caught and retained in the gulches; the rest, intermixed with gravel and boulders from the metamorphic rocks, and also from the limestone and recent formations in the foot-hills, being carried far out on the plains, and scattered broadcast over their surface, so that very little can ever be recovered. From the results of the prospecting done in this district up to August 1, 1875, it would be inferred that the character of the bed-rock strongly influenced the deposition of the gold. Where the bed-rock was a hard, massive quartzite, the water had worn it smooth, and no gold was to be found on its surface, while the gravel above it was loose and poor in the precious metal; but where the bed-rock was soft, easily-decomposing slates, it had caught and retained the gold swept over its surface by the stream; and the gravel above, compact from the clay produced by its decay, was also rich in gold. In the flats and creek bed, when a stratum of soft slates is found crossing the gulch below, a high and hard bar with valuable deposits should be sought for.

Whiskey Creek.—From the fact that the area drained by this stream is almost identical in the character of the rocks with that of the Spring Creek district, although less extensive, Jenney considers that there are good reasons to expect that, at least in some localities, gold may be found in paying quantities in the gravel deposits of Whiskey Creek and its tributaries.

Castle Creek.—Gold was discovered on Castle Creek, above the cañon, on June 12, 1875. It was found in small gravel deposits along the creek, and in the gulches leading into the stream from the south. About 2 or 3 miles below the point where Custer's trail leaves the valley, a bar, covering an area of 2 acres, gave, on prospecting, nearly 1c. (½*d.*) to the pan of fine gold. This deposit of gravel was 4 to 5 ft. in thickness, composed of quartz and slate pebbles, resting on bed-rock of mica-schists, elevated about 6 ft. above the water of the creek, and so favourably situated for working that the gravel could be sluiced with very little expense or trouble. Several pits were sunk in the flats near the channel of the stream, but failed to reach bed-rock, owing to springs of water, which could not be kept down by baling. Small gravel benches were found on the sides of the cañon below this bar, which gave 4 to 6 colours of gold to the pan, but were of too limited area to be valuable.

The gold from this portion of the stream is in small flat grains, resembling that of French Creek, and probably similarly derived from the quartz veins in the schists. In July, a party of miners discovered gold in paying quantities on Castle Creek, below the north bend. The pay-dirt gave, by several tests, 5c. to 15c. (2½*d.* to 7½*d.*) to the pan of coarse rusty gold.

Rapid Creek.—Samples of quartz from the hills between Rapid and Box-Elder Creeks gave, on crushing 2 or 3 oz. in a mortar, and panning, 4 to 6 fine colours of gold. Gold was discovered in paying quantities in a number of places along this portion of the valley; but the miners did not open the placers, and prospected the bars only enough to prove the presence of gold. These deposits of gravel, including both the high bars and narrow flats in the cañon, are known to be valuable, resembling those of the Spring Creek district.

Reports from Rapid Creek, dated December 31, 1875, stated that "the cañon is located from head to mouth, and 10c. (5*d.*) to the pan is considered a low average prospect in the pay-streak."

Box-Elder and Elk Creeks.—There are a few low bars on the larger branches of Box-Elder which may be found to contain gold in workable quantities; but the only gravel deposits of any size are in the flats along the stream and its numerous branches.

Spearfish and Bear Butte Creeks.—Just above the mouth of the cañon, several small streams enter Spearfish from the south-west, heading in the ridge between Spearfish and Floral Valley. On these branches a party of miners discovered rich placer deposits. One pan of dirt on the discovery of Bear Creek contained $27 (5*l.* 12*s.* 6*d.*), and one man took out with a rocker, in 8½ days, $165 (34*l.* 7*s.* 6*d.*).

Among the mica-schists on the head branches of the east fork of Bear Butte Creek, the soldiers found gold in the gravel deposits of the side gulches of the stream; and a piece weighing about ½ dwt. was obtained from one of their prospecting pits near Camp Terry. Gravel deposits of considerable extent are reported in the valleys of the branches of the east fork, but have not as yet been prospected by the miners. Gold has been discovered by the miners on Deadwood and Whitewood Creeks, and the numerous gulches running into them in the vicinity of Terry Creek. The placers are extensive, and in most places the bed-rock is reported to be near the surface; and the gold is doubtless derived from the disintegration and erosion of the igneous rocks, as well as from slates and quartzites.

Having detected gold in similar trachytes in the Bear Lodge range, Jenney considers its occurrence in rocks of igneous origin in this district as extremely probable.

Bear Lodge.—Half a mile north-east of the central peaks, a gold-bearing ledge was discovered and traced in a north-west and south-east direction for several hundred yards. On examination, it was found to be irregular in shape, without any well-defined walls or boundaries, and merging on all sides into the adjacent trachyte rocks.

Prospecting in the dry ravine a short distance below this ledge, the gravel from off bed-rock was found to be largely composed of material derived from the disintegration of the ledge. Twelve fine colours of gold, or about ½c. (¼*d.*) to the pan was obtained. It would seem probable that the whole of the gold contained in the gravel in this ravine has been derived from the decomposition and denudation of the above ledge.

The occurrence of gold in trachyte, without any quartz being associated with it, has been previously reported from several mining districts in the West.

Exploring a number of small streams rising near Warren Peaks, flowing to the north and east, gold was found in gravel deposits in the flats along the banks of the creeks in several places, but nowhere in paying quantities. The streams being small and the wash not very great, there were no high gravel deposits, though one or two bars covering about an acre were observed occupying flats elevated 3 or 4 ft. above the creek. These deposits were situated so that they could be readily worked, but only yielded, on testing, ⅛c. to ½c. ($\frac{1}{16}$*d.* to ¼*d.*) to the pan in very fine dust.

The gold is derived from the igneous rocks forming Warren Peaks, most of it apparently from the manganese and limonite ledge on the north-east slope, as the largest quantities were found in the ravines heading near that point.

In reviewing this small district, which is very interesting scientifically, even if the deposits of gold should not be found of workable richness, it may be stated that the bars are of limited area, and usually shallow deposits of felspar gravel. The gold is fine, and up to the present time has not been found in remunerative quantities. The water-supply is small, but probably sufficient for working purposes during the spring months. The district is remarkable in the occurrence of gold without any quartz whatever being associated with it, and in the fact that the gold is derived from felspar trachyte-porphyry of recent geological age.

Auriferous Gravel in the Foot-hills.—A belt of gravel deposits, resting usually on the Red beds near the edge of the plains, extends from Red

Cañon Creek, in the extreme southern end of the Black Hills, all along the south-eastern foot-hills, across the valley of Minnekata, Amphibious, French, Wiwi, Whiskey, Spring, and Rapid Creeks to Box-Elder, where it thins out and disappears. On examination, these gravel beds seem to be river deposits, though in places they cap hills 300 ft. above the present bed of the nearest stream. Where the divides between the creeks are quite wide at the edge of the plains, the gravel is seen to be thickest and most extensively deposited near the valleys of the streams, and to thin out toward the crest of the divides. The gravel appears to have been deposited by the water at the point where the power of the stream became insufficient to transport farther in large quantities boulders of this size and weight, and the beds resemble somewhat shore or estuary deposits, such as are formed near the mouth of a stream emptying into a lake or sea. These gravel banks have been formed since the elevation of the Black Hills; and the great Tertiary sea which gave rise to the extensive beds of that age in the valleys of White River and the South Cheyenne may have reached to the foot-hills of this range. A gravel "wash" from the Black Hills is found all over the surface of the plains to the north, east, and south of the range. Near the Cheyenne, this gravel forms a conglomerate 6 ft. in thickness, between the top of Cretaceous No. 5 and the base of the White River Tertiary, and also occurs as scattered gravel boulders on the tops of the Tertiary hills, showing that it has been deposited since the close of the Cretaceous period, both before and after the later Tertiary. These gravel beds are made up of a mixture of boulders and pebbles from all the harder rocks found in the different geological formations on the eastern slope of the Black Hills, including granite, trachyte, schist, slate, quartzite and quartz in all its varieties, mixed with a variable proportion of sandstone and limestone from the disintegration of the Potsdam, Carboniferous, and Red beds.

Where Rapid Creek bursts through the foot-hills and flows out on the plains, are very extensive gravel beds of this character, evidently deposited by the stream at different periods, as they cover the tops of hills at three distinct elevations, respectively at about 50 ft., 100 ft., and 300 to 350 ft. above the present bed of the creek. The lowest of these deposits occupies benches and flat-topped hills formed of the soft red sandstone of the Red beds. The gravel is mostly composed of limestone and sandstone boulders, mingled with quartz, slate, and ferruginous quartzite. The next, also resting on the Red beds, is of similar character; not more than 50 per cent. of the gravel is derived from the metamorphic rocks. Both these deposits are on the side hills of the valley, in places forming banks or terraces 20 to 30 ft. in height, and should properly be classed as high bars. The gravel from off bed-rock, obtained by drifting into the face of these bars a distance of 4 or 5 ft., gave Jenney one to two colours of gold to the pan. The highest gravel deposits are in places 30 to 40 ft. in thickness, capping the tops of the hills of Carboniferous and Triassic limestones, often at a considerable distance from the present valley of the stream; the lower layers contain water-worn boulders, 1 to 2 ft. in diameter, of quartz, slate, quartzite, granite, and trachyte, both felspathic and hornblendic; but scarcely a trace of limestone or sandstone rocks is found in these more elevated deposits. Wherever tested, the gravel from off bed-rock gave small quantities of gold on panning.

In the dry side ravines of Whiskey Creek, among the Red beds, gold was discovered by a party of miners entering the Hills. Prospecting up a dry gulch, they obtained 25 colours of gold from the dirt shaken from the roots of a small bush growing in a narrow crevice in the bare sandstone bed-rock at the bottom of the ravine. This locality, known as the "Rosebush diggings," derived its gold from the gradual washing down into the ravines of the gravel deposits capping the hills by the action of occasional heavy rains, when for a short time a stream of water would flow through the gulch, and sluice the gravel accumulated in it, the gold being caught in the crevices of the bed-rock, while the dirt was swept away. Prospecting in one of these side gulches, about ½ a mile from the main stream, the dirt from the crevices in the bed-rock was found to yield 5c. to 15c. (2½*d.* to 7½*d.*) to the pan. The gold was in fine particles, associated with small red garnet crystals, derived from the schists in the neighbourhood of Harney Peak. This ravine was excavated about 200 ft. in depth through the Red beds. Its bottom was formed of a pavement of the upper layers of the Carboniferous sandstone, while the hills on both sides were covered with a deposit of slate and quartz gravel which had furnished the gold.

A mile below, the small side gulches in the Red beds afforded in places 5c. to 10c. (2½*d.* to 5*d.*) to the pan of gold; but the supply of water at this time (July 20) was so small that the miners decided to give up prospecting in the vicinity, and abandon the diggings until the spring rains should fill the water-holes, and make it possible to work the pay-dirt in rockers, if rich enough deposits should be discovered.

About 5 miles south of Whiskey Creek, at the edge of the plains, conglomerate 30 ft. in thickness caps hills 100 to 150 ft. in height, of the soft sandstone of the Red beds. The conglomerate is composed of granite, quartz and slate boulders, cemented by sand and lime into a loosely-cohering "cement," the lower layers of which contain quartz boulders 1 to 2 ft. in diameter. The small gulches in the vicinity are full of the quartz gravel resulting from the decomposition of the conglomerate, and undoubtedly contain gold; but unfortunately there was not a drop of water anywhere to be found in the neighbourhood, and Jenney was obliged to relinquish the attempt to prospect them. Similar gravel deposits encircle the foot-hills, crossing the valleys of French, Amphibious, and Minnekata Creeks.

Should these elevated gravel deposits on further exploration be found to contain throughout their thickness sufficient gold to warrant working by the hydraulic process, water can be conveyed from the streams in the Hills to them in many places under a considerable head, as they are elevated only about 3800 ft. above the sea, while the streams, 15 miles in the interior, are flowing through valleys at an elevation of 5000 ft. On Rapid Creek a large volume of water, at least 2000 "miners' inches," under a head of 75 ft. to the mile, can be made available for working these high bars above the valley, at a moderate expenditure of capital and labour required to construct the flumes. Only two streams, Rapid and Minnekata, having gravel deposits of this character in their valleys, form a continuous stream of water to the Cheyenne; the rest all sink in their beds among the foot-hills, several miles from the plains. Among some of these dry ravines, cutting through the gravel deposits, miners in the future may make good wages by washing the earth from the bottoms of the gulches in rockers during the early spring months, when there is a sufficient supply of water in the vicinity.

Georgia.—In 1799, large lumps of gold were found in Georgia, one weighing 28 lb.; this incited exploration, and in the early part of the present century, the rush to the mines resembled that to California in 1849. Between 1838 and 1856, the gross product of gold, so far as indicated by the Mint Returns, was $5,685,864 (1,184,555*l.*). W. P. Blake, writing in 1858, makes the total to the end of 1855 as $6,488,932 (1,351,860*l.*), and states the fineness at 928 on the average of assays made over a period of 20 years.

This author affirms that gold is almost uniformly distributed in the soil and drift on the hills and hillsides, and in the valleys and dry ravines of Lumpkin county, and adds that water from the Chestatee River may be had in abundance, and at an elevation sufficient for hydraulicing all the deposit. He is further "much impressed with the close similarity of the gold-deposits to those of portions of California. The great difference between the two regions appears to be in the scale upon which they are developed." "The hills are formed of gneiss and mica-slate on edge, traversed with auriferous quartz veins, and covered with beds of drift as in California. Gold occurs not only along the streams in gravel, but is found high on the hills under accumulations of river-drift, gravel, and clay. River gravel and gold are found here at 200 to 300 ft. above the streams. Many of these deposits on the hills give evidence of great richness," but have been neglected owing to their distance from water.

According to the official report of the State Geologist, Dr. George

Little, the gold-belt of Georgia is about 100 miles in breadth, with barren intervals here and there. It lies north-east and south-west across the entire northern and part of the eastern section of the State. It extends through a large number of counties. But few mines have been developed in Columbia and Lincoln counties, but they are claimed to be among the richest in the State. A vein near Goshen, in the latter county, is said to be yielding at the present time $1000 (200*l.*) per month, at a cost of but $115 (23*l.*). While many very rich and profitable mines have been opened in the lower portion of the belt, the greater proportion of the mining has been done in the northern or mountainous section, especially in the counties of Lumpkin, White, Union, Dawson, and Cherokee.

"The gold occurs under three distinct conditions:—(1) as sand (dust) or pebble (nuggets), forming integral portions of the deposits of sand and gravel along the streams, which sometimes extend as high as 100 ft. or more above the stream levels; (2) as grains, strings or masses, forming integral portions of extensive beds of schists, which are sometimes accompanied by layers of quartz of greater or less thickness, and are sometimes destitute of the least particle of quartz; (3) as a part of the whole of the mineral contents of quartz veins.

"The quartz veins vary in thickness from a few inches to 10 ft. or more, and have seldom been worked below the water level, from want of capital to purchase the necessary machinery. The ore, when obtained from the veins, is pounded in mills run by water-power, and generally varies from $5 to $50 (1*l.* to 10*l.*) per ton, the cost of handling being about 50c. (2*s.* 1*d.*) per ton. There are, however, many instances where the yield has been as high as $60 and even $100 (12*l.* to 20*l.*) per ton."

According to P. H. Mell, there are three points of special interest where gold has been obtained in large quantities, mostly by rude and primitive appliances, viz. Dahlonega, Allatoona Hills, and Burnt Hickory. From these localities and intermediate points, during the fiscal year 1875–6, there was produced $7,379,000 (1,537,292*l.*)

Idaho.—Gold is found in Idaho in both placers and veins. The former have been worked at a good profit in nearly every county, and during 1880 many new and rich deposits were opened up in the Wood River district, Salmon River Mountains. The chief veins now being exploited are in the Salmon River and Owyhee Mountains. On the Snake River placers, in 1864, gold-dust to the value of $2,500,000 (500,000*l.*) was collected and sent through regular transporting agencies, and it is estimated that nearly as much more was forwarded by other means. The apparatus first employed was a rocker provided with an amalgamated copper plate, which afterwards gave place to improved appliances, described in another chapter. The gold is exceedingly fine, and occurs with a heavy black sand. Most of the mines are of argentiferous galena containing some gold, and the bulk of the ore is sent to Salt Lake City for treatment. The Wood River district was reported to have produced over $1,000,000 (200,000*l.*) worth of bullion in 1881, but there is nothing to show what proportion is gold.

Maine.—Important discoveries of gold-deposits have been made in Maine lately (Scien. Amer., xlii. 122). The shaft of the Fort Knox mine, at Prospect, opposite Bucksport, on the Penobscot River, is now (1880) down 62 ft., and the ore from the bottom contains both gold and silver. Mineral from the Deer Isle mine, on Deer Island, Penobscot Bay, gave $30 (6*l.*) worth of gold per ton, besides other metals. The Owl's Head mine, 7 miles below Rockland, at the mouth of Penobscot Bay, is showing specimens of quartz very rich in gold.

Missouri.—According to G. C. Broadhead, gold has been found in Missouri, in Chariton, Linn, Adair, Putnam, Sullivan, and Mercer counties. It is in very small grains, the largest particles, from Adair county, being no larger than a grain of wheat.

Montana.—Raymond (1876) remarks that the yield of the placer-diggings has steadily decreased for some years, mainly owing to want of combination among the miners in bringing water and building flumes. Still the total placer-gold obtained in 1875 was valued at $2,400,000 (480,000*l.*) contributed as follows:—Deer Lodge county, $900,000 (180,000*l.*) Old Alder, and other gulches in Madison county, $450,000 (900,000*l.*) Bannack and vicinity, $300,000 (60,000*l.*); Cedar Creek and Quartz Creek, Missoula county, $100,000 (20,000*l.*); Confederate Gulch, and the gulches and bars in Meagher, $300,000 (60,000*l.*); Gallatin county, $50,000 (10,000*l.*); Jefferson, $150,000 (30,000*l.*); Lewis and Clarke, $350,000 (70,000*l.*).

The gold-product during 1876 was $3,925,000 (817,710*l.*). According to Clark, Centennial Historian for the Territory, the yield has been:—

Year.	$
1862	600,000
1863	8,000,000
1864	16,000,000
1865	18,000,000
1866	17,000,000
1867	16,000,000
1868	15,000,000
1869	11,000,000
1870	9,000,000
1871	8,000,000
1872	7,000,000
1873	5,200,000
1874	4,100,000
1875	4,100,000

Most of this was gold-dust ranging above 900 in fineness. The enormous production of the years 1864–8 was due to the rich placer-diggings found in the gulches of the Missouri head tributaries.

Beaver Head county.—From the first settlement of Bannack, in 1862, till 1875, not less than $3,000,000 (600,000*l.*) worth of precious metals (including silver) have been taken out, mainly from the placer-diggings.

The first veins of auriferous quartz discovered in the territory are also in this district. In the Blue Wing district, the gold mostly occurs in argentiferous galena.

Deer Lodge county.—The hill-side placer-diggings below the Atlantic Cable mine have given large returns, but are now probably exhausted. The Atlantic Cable mine, says Raymond, "lies in a zone or dyke of crystalline limestone, which is enclosed by granite." The dyke runs N.E. and S.W., and dips N.W. at the surface. The ore-vein is irregular in dip, strike, and width, but everywhere too wide for convenient timbering. The ore is soft, highly iron-stained, porous quartz, which frequently contains decomposed ores of copper; the average value is stated at $22 38c. (4*l.* 13*s.* 3*d.*) per ton. The North Pacific lode is supposed to be an extension of the Atlantic Cable, and resembles it in every respect; the occurrence of "white limestone fragments in the vein-matter, and the environment of the richest by spar, is a feature of both lodes."

The Pyrenees vein runs S.E. and N.W., between granite walls, with a 6-in. seam of white clay separating the quartz from the wall-rock, the latter being perfectly defined, and the vein varying in width from 18 in. to 3½ ft. The rock is dark-brown quartz, showing particles of free gold. The Whin-Doodle, Pittsburg, and Four Johns veins closely resemble the Pyrenees in all principal features, the ore being valued at $40 to $50 (8*l.* to 10*l.*) a ton. The North Atlantic and Rosa Whitford veins, on the other hand, are similar to the Atlantic Cable, and average about $20 (4*l.*) a ton.

Nearly all the argentiferous galena veins of Montana yield more or less gold, helping to swell the total product of that metal, without claiming particular attention from a gold-mining point of view.

Nevada.—The gold production of Nevada for the fiscal year ending June 30, 1880, according to Porter, was:—Storey county, $3,323,840 (692,427*l.*); Eureka, $1,167,383 (243,200*l.*); Humboldt, $78,994 (16,457*l.*); Elko, $68,538 (14,279*l.*); Nye, $28,572 (5952*l.*); Lyon, $23,773 (4953*l.*); White River, $18,396 (3832*l.*); Lincoln, $7861 (1637*l.*); Esmeralda, $953 (199*l.*); Lander, $760 (158*l.*).

This state is especially remarkable for possessing the renowned Comstock lode, and several gigantic mining enterprises (e.g. the Richmond, Mineral Hills, &c.), in which a very large British capital is invested.

The Comstock lode has been described at tedious length by numbers of writers, but the summary of its formation has been succinctly stated by Clarence King in the following paragraph:—

"The ancient Virginia Range, prior to the Tertiary period, was composed of sedimentary beds of the Great Cordillera system, which, in the late Jurassic epoch, had been folded up, forming one of the corrugations of that immense mountain structure which covers the western front of the American Continent. Accompanying this upheaval were outpourings of granite and syenite. The erosion which followed this mountain period escarped the ancient rocks, and modelled the eastern point of Mount Davidson into a comparatively smooth surface, whose average angle of slope sunk to the east at almost 40°. In the late Tertiary, at the time of the volcanic era, the Virginia Range shared in the dynamical convulsions which gave vent to excessive volcanic outflows of immense volume and very remarkable character. The first, and, so far as the Comstock lode is concerned, the most important, was of propylite, or trachytic greenstone, which deluged the range from summit to base, covering large portions of its ancient surface, and leaving here and there isolated masses, which rose like islands above the wide fields of volcanic rock. Subsequently followed the period of the andesites, which, at their commencement, in the form of a thin intrusive dyke, penetrated a new-formed fissure on the contact plane of the ancient syenite and propylite. This earlier andesite period gave birth to the solfataras, which, bursting from a hundred vents, rapidly decomposed the surrounding rocks, and gradually filled the fissures of the Comstock with their remarkable charges of metal-bearing quartz. The latest flows of andesite poured out over the decomposed propylite, and since they are themselves unaltered, their appearance marks the period when solfataric action over wide areas had ceased. While it no longer maintained its energy through the broad zone of propylite, it still continued intensely active within the chambers of the Comstock lode. Metallic contents were introduced into the quartz, the clay-seams were formed by a rapid decomposition of the neighbouring propylite materials, the lodes reduced to a spongy semiplastic condition, and at last the final solidification of the quartz took place. Outside of the vein, two events of geological interest have occurred: first, the period of trachyte eruptions, when from the ruptures of the crust, parallel to the Comstock lode, vast volumes of sanidin-trachyte overflowed the country; and, secondly, the less powerful but still important outpouring of basaltic rock, which marked the close of the volcanic era. Within the vein, and probably caused by one or both of these latter volcanic disturbances, a pressure has been exerted which has crushed and ground the masses of quartz into minute fragments. It is interesting to observe that, while this force was great enough to crush quartz-masses 150 ft. in breadth into mere angular pebbles, the disturbances were insufficient to cause any actual faulting of importance. Both within and without the vein, solfataras gradually came to a close. The heated currents of water, which even yet ascend into the lower levels of the mines, are evidence that at no very great depth a considerable temperature is still maintained; but this is only a faint relic of a once intense action."

Again, he remarks that "quartz forms the only gangue in the Comstock lode. Those small masses of carbonate of lime, which occur, intermingled with quartz, in the Gold Hill and Hale and Norcross lower levels, are rather to be considered an included mineral of accidental occurrence than as a true gangue. With the exception of small quantities of silver minerals contained in the clay sheets, where they are placed in contact with the bonanza, the whole silver-tenure of the lode is contained in the bodies of quartz. The ore itself is composed of native gold, native silver, silver-glance, stephanite, polybasite, rich galena, occasional pyrargyrite, horn silver, and, with extreme rarity, sternbergite. Intimately associated with these, occur iron- and copper-pyrites and zinc-blende. Of these, pyrargyrite and horn silver are rarities; polybasite and sternbergite, in recognizable crystals, occupy a few scattered localities; stephanite, in defined crystallizations, has been found in nearly every bonanza; but the main body of the ore is a confused semi-crystallized association of native gold and silver, vitreous silver ore, rich galena, copper- and iron-pyrites, and zinc-blende." The following two analyses are of samples from the Savage and Kentuck lower workings of 1869:—

ANALYSES OF COMSTOCK ORES.

	Savage.	Kentuck.
Silica	83·95	91·49
Protoxide of iron	1·95	0·83
Alumina	1·25	1·13
Protoxide of manganese	0·64	..
Magnesia	2·82	1·37
Lime	0·85	1·42
Sulphide of zinc	1·75	0·13
Sulphide of copper	0·30	0·41
Sulphide of lead	0·36	0·02
Sulphide of silver	1·08	0·12
Gold	0·02	0·0017
Bisulphide of iron	1·80	0·92
Potassa and soda	1·28	1·05
Water	2·33	0·59
	100·38	99·48
	W. G. Mixter.	A. Hague.

In a report dated Feb. 10, 1873, addressed by Clarence King to the chairman of the Richmond mine, it is stated that the Eureka district, and a wide extent of surrounding country, are made up of a series of broad mountain folds, having an approximately north and south trend. Carboniferous, Devonian, and Silurian strata, amounting to not less than 12,000 ft. in thickness, form the main part of this system; with volcanic rocks of the trachytic and basaltic families, here and there breaking through and overflowing the sedimentary formations. Anticlinal crests usually form the mountain chains, which average about 10,000 ft. above sea-level, and are separated from each other by broad meridional valleys of 4000 and 5000 ft. altitude. Dislocation, faulting, intense metamorphism, and violent aqueous erosion, have combined to give an especially rugged and precipitous topography to the region. Eureka district itself lies at the point of junction of two converging ranges, the Diamond and Pinõn, belonging by its position more strictly to the former; but geologically it would seem to be more intimately allied to the latter.

Ruby Hill, within which is the Richmond Mine, is a partly detached fragment of the northern half of a local mountain fold, which has left the prevalent north and south course, curving round nearly into an east and west trend. It is therefore locally a geological exception as to its dip and strike. To this wide departure of trend is probably due the extreme metamorphism and dislocation which it has suffered. The basis of the hill is a series of quartzite strata, conformably upon which lie a thick group of limestone beds, belonging to the Silurian formation; the main strike is about N. 60° to 65° W., with a dip of about 30° N.E. Extreme outbursts of recent volcanic material at the west base of the hill, and again near Eureka Town, probably fix the age of the mineralization of Ruby Hill ore-bodies within the Miocene period, a time (throughout this region) fertile in deposits of large wealth, such as of the famed Comstock. Thus early in their development, it is somewhat difficult to classify these ore-bodies; but it is quite within the limit of safety to say, that all the Ruby Hill mines are on one large "bed-vein," which has been crushed, moved, and shattered to such an extent as to interrupt the ore sheet, if indeed it were ever quite continuous.

The country limestone is more or less shaly and siliceous near the quartzite, but, in passing upward, compacts into thick heavy masses, whose original bedding is almost utterly lost, resulting in a massive capping, shattered by irregular jointed planes, and everywhere seamed and impregnated with veins and bunches of calc-spar. The ore-bodies occupy the shattered shaly limestone zone, bounded by the quartzite below, and the more massive limestone above. As must inevitably be the case with all similar deposits, the walls of this bed-vein are more or less irregular and undulating: the included ore-mass pinching or widening in accord with the accidents of pressure and metamorphism; hence the remarkable changes in dip and thickness which characterize it.

The foot-wall, wherever developed, is quite defined, more or less marked and streaked, with occasional clay selvages, which are never important or continuous. The hanging-wall is still less perfectly defined,—it is characterized by a broken surface, and by a zone of broken limestone blocks detached from the hanging country, and lying within the vein-material, surrounded by bunches of ore and masses of oxidized ferruginous gangue. Between these walls, for an average thickness of 60 ft., lies the mass of ore, for the most part fairly uniform in appearance and composition. Galena, somewhat shattered and decomposed, is conspicuous in the region of the foot-wall; lead carbonates are freely mingled through the middle, while highly oxidized ferruginous ore, carrying a higher tenure of gold, predominates near the hanging-wall.

In the half year ending Feb. 28, 1875, this mine turned out 18,000 tons of mineral, the yield from which was: gold, 62,000*l.*; silver, 109,000*l.*; lead, 51,000*l.* The weights of the metals respectively were: gold, 1200 lb.; silver, 35,000 lb.; lead, 3000 tons.

A report on the mine by J. D. Hague, dated Nov. 8, 1877, states that it "is found in a belt of limestone, which forms the principal mass of Ruby Hill, a low outlying spur of Prospect Mountain. This limestone rests upon an underlying formation of quartzite on the south, and is overlaid, at least for a portion of the length of ground explored, by a belt of shale on the north. The general trend of this formation is easterly and westerly; and the beds are inclined to the northward, at a variable angle to the horizon, sometimes very steep, and often, especially the quartzite, less than 45°. The thickness of the limestone belt, between the quartzite and the shale, also varies very much, being 1200 ft. or more on the surface, and about 225 to 300 ft. in the deeper levels of the Richmond mine, or its neighbour on the south-east, the Eureka."

The mixed nature of the ores of all this region requires them to be submitted to metallurgical processes, a multiplicity of which have been introduced at different times and with varying results, and will be fully described in another chapter.

New Hampshire.—Gold is found (Amer. Jl. Min., vi. 169), in the galena of Gardner's Mountain, Lyman township, Grafton county, and in the Lyman Hills. At a gold-mine (Scien. Amer., xxxi. 378) about 1½ miles east of Mount Monadnock, several assays of the quartz are said to have averaged $100 (20*l.*) a ton, the ledge in which the gold is found covering 32 acres.

New Mexico.—Some years since, great excitement was occasioned by the finding of gold in the Jacarilla [Jicarilla] Mountains. The diggings are shallow placers, the top ground of which has yielded 10 to 25c. (5*d.* to 12½*d.*) to the pan. They are extensive and deep, but the complete absence of water prevents any other than the "dry" method of washing being used. In 1878 (Proc. R. Geog. Soc., xxii. 275), the diggings were comparatively deserted.

According to O. St. John, on the upper course of the Mareno, in the vicinity of Elizabeth Town, is situated one of the famous mining centres of the territory. The auriferous lodes intersecting Great Baldy have distributed their wealth in the beds of the gulches furrowing its sides. In the lower course of Grouse Gulch, an extensive placer claim is (1876) being worked by the hydraulic method. The deposit rests upon a layer of partially-indurated, tenacious, red clay, of considerable depth, being the superficially decomposed bed-rock, a coarse-textured light granite.

In 1861, W. P. Blake, of Dahlonega, Georgia, published some observations of his tour of exploration made in 1857 in the mountains of the northern part of New Mexico, near Santa Fé, from which the following remarks are taken. This gold-field has been known and worked since 1828. It is confined to the Placer [Gold] Mountains, about 20 miles from Santa Fé, towards Albuquerque, and although worked continuously since its discovery, its limits have not been extended by exploration far from the place where the gold was first found. The yield of gold has been chiefly from the placers or washings, and not from veins, and was estimated by Wislizenus, in 1847, to vary from $30,000 to $250,000 (6000*l.* to 50,000*l.*) a year; but it soon after greatly diminished, until counted by hundreds rather than thousands. Blake found these placers to be on the slopes of subordinate or outlying ridges of the eastern ranges of the Rocky Mountain chain, and to be true hill-deposits affording coarse gold, like that from the high placers of California. The "pay-gravel" lies deep below the surface (20 to 60 and even 100 ft.), and is generally very rich. Owing to the almost total absence of water, mining and washing have been but imperfectly conducted, and a large amount of gravel remains untouched. The Mexicans sink circular shafts, like wells, through the soil and alluvions to the gravel; tunnel upon the bed-rock; take the good gravel to the surface in sacks; cart it 2 miles to water; and then pan out the gold in wooden bowls or *bateas.* In the winter, water is sometimes obtained by melting snow with heated stones. There are two principal placers, the "old" and the "new;" at the former there is a small stream or rivulet for a part of the year.

These placers are about 5 miles apart, but there has been very little prospecting to determine their real extent. New Placer is known to be about 10 miles long, for the workings or pits have extended over that distance. The gold appears to have washed out of two cañons in the mountain, which are near together, and seem to drain but a very small part of the surface. Veins or beds containing gold crop out higher up in the ravines of the mountains. It is remarkable that in one place, at least, gold occurs in strata of quartzose sandstone, probably of Carboniferous age, and in great ferruginous beds, rather than in veins. The sandstone appears to have been charged with auriferous pyrites, by the decomposition of which the gold has been liberated. At other points, regular quartz veins bearing gold-pyrites are found, and some of them have been worked at different times for over 20 years. The Ortiz mine has been worked to a depth of 135 ft., and levels driven for nearly 200 yd. on the course of the vein, which is represented to be about 6 ft. thick. The Biggs' mine, which adjoins it, has been worked to nearly the same depth. In the mountains known as Los Cerillos, about 8 miles from New Placer, there is a deserted mine, known among the old Mexicans as La Mina del Oro, the true character of which could not be well determined. It certainly is very ancient, and there is no record or tradition concerning it, except that the work was done before the Insurrection, which took place in 1680. The principal shaft is over 200 ft. deep, and is cut vertically, with great precision, through solid rock. The sides are very smooth, and it is evidently the work of experienced miners. A stone, allowed to drop vertically, does not reach the bottom for several seconds, and then gives a dull sound as if striking earth, showing that there is no water in the mine even at that depth. There are two other shafts, and they all communicate by galleries in miners' style. In 1834, there was an attempt made to clean out the mine and work it, by a party of Mexican residents of Santa Fé, but without any success, there being no water nor machinery for raising and reducing the ore.

At the placers, large lumps, *pepites*, or nuggets of gold have been frequently found; the largest of which Blake could get reliable information was worth about $2000 (400*l.*), another was valued at $1800 (360*l.*) and there have been many worth from $50 to $80 (10 to 16*l.*). At Old Placer, none larger than about 80 dwt. had been found. The gold from New Placer is remarkably black and ill-looking on the surface, but is very fine, being worth $20 (4*l.* 3*s.* 4*d.*) an oz. Only $16 (3*l.* 6*s.* 8*d.*) an oz. is paid for it to the Mexicans at the mines by the traders. When these miners are employed by the day they receive 60 to 75c. (2*s.* 6*d.* to 3*s.* 1½*d.*) a day.

The Gold Mountains and Placers are about 300 miles south of Pike's Peak, and there is little reason to doubt that gold will be found at intervals, if not in an almost continuous belt, over this entire distance. The New Mexican gold-field is probably much more extensive than is generally supposed, and when it is thoroughly prospected, many more rich placers will doubtless be found. The geological indications in the mountains north of Santa Fé, judging from specimens brought to Blake, are favourable to the presence of gold, and are more like the auriferous rocks of other gold-regions than the formations at the Placer Mountains.

The observation of the occurrence of gold in beds of sandstone is not only interesting to science, but of considerable practical importance. The erosion, or breaking down of such a bed would supply gold to a stream or deposit without its being accompanied at the same time by the usual beds of quartzose gravel, the soft friable sandstone being completely broken up into sand by attrition. Thus, rich deposits may exist on the hill sides without any indication of their presence by beds of rolled gravel or broken fragments of veins on the surface. Green Russell, an experienced placer-miner and mountaineer, who made an extended tour through the new gold-region of Western Kansas in 1856, informed Blake that he had observed such conditions, having found rich deposits of gold without much gravel and scarcely any quartz. This authority also states that gold occurs in considerable quantities upon the Arkansas River, in extremely thin scales, as low down as the crossing of the old Santa Fé road, near old Fort Atkinson. This is far out upon the broad plains, and below any coarse alluvions. The quantity of gold increases as the river is ascended, and the best prospects were obtained at the Pueblo above Bent's Fort. The Arkansas, near this point, has several forks or branches heading in the mountains to the southward, in the vicinity of the Spanish Peaks; and there is much reason to believe that gold will be found there. A connecting link between the New Mexican gold-field and that of Pike's Peak would thus be formed. A sample of the Arkansas River gold, brought in by Russell, yielded 971 by assay at the Dahlonega Branch Mint, being worth about $20 (4*l.* 3*s.* 4*d.*) an oz., or nearly the same as the New Mexican gold. It would thus appear that the Rocky Mountain gold is of superior quality, the average of the Californian gold being from 875 to 885, and the Australian 960 to 966.

New York.—Four well-defined gold-fields are stated to exist in New York state:—(1) Commences somewhere about Plattsburg, and runs south into Hamilton, Fulton, and Saratoga counties, then dividing into two branches, west into Herkimer and east into Washington county; (2) in Dutchess county; (3) in Westchester and Rockland counties; (4) in Erie and Alleghany counties. Near Clinton, an auriferous vein of quartz (Ann. Rep. Amer. Inst. City N. Y., xxv. 827), varying in width from 6 to 12 in. has been traced to a distance of 3000 ft. on the surface; samples have been found to contain $15 45c. (3*l.* 4*s.* 4½*d.*) worth of gold per ton.

Reports on the auriferous quartz veins of Rhinebeck, Dutchess county, have recently (1869) been published (Amer. Jl. Sci. and Arts, xlvii. 139) by Prof. J. G. Pohle and Prof. John Torrey. According to the former, there are 4 veins dividing the talco-argillaceous schist in the direction of the cleavage. The quartz is cellular and brown with oxide of iron, arising from the decomposition of pyrites; but below it is more compact, and the pyrites is unaltered. Analysis of the rock afforded Prof. Pohle 963 to 975 thousandths of gold, the rest almost solely silver. Prof. Pohle adds that the geological formations on this property are of the Lower Palæozoic age; the Potsdam periods of it are well represented by the metamorphic slates and the calciferous sandstone, but no fossils have thus far been found. The slates (argillaceous mainly) form a characteristic feature of the whole Appalachian range, and the presence of gold here supplies the link heretofore wanting in the chain of the Appalachian gold-fields; "for there can be no doubt that this is a part of the grand belt taking its rise on the St. Lawrence river, and scattering its auriferous treasure for 1300 miles along the south-eastern border of North America, terminating in Alabama."

Dr. Torrey assayed a quantity of the quartz procured by him at the mine, it being "a fair average of the lode," and amounting to several hundred pounds, and states as his results, that of 3 assays, the average yield of gold per ton of ore (2000 lb.) was $118 49c. (24*l.* 13*s.* 8½*d.*). In no case was the proportion of gold less than $100 (20*l.* 16*s.* 8*d.*) per ton.

Ohio.—Professor Andrews observes (Geol. Survey, p. 133) that gold has been taken from the drift at several points in Licking county, and that in the summer of 1868, gold-dust was gathered to the value of $17 (3*l.* 10*s.* 10*d.*).

Oregon.—The gold-fields of Oregon are said to have produced $1,050,000 (218,750*l.*) worth of gold in 1879. Condon observes that the auriferous regions of Oregon centre in its mountain chains, viz. the Coast and Cascade Ranges, and the Blue, Siskiyou, Umpqua, Calapooya, Snow, and Puebla Mountains. The gold of the Coast Range and of its cross-spurs the Siskiyou, Umpqua, and Calapooya Mountains, has only been found in paying quantities on the sands of the sea-beach, forming a continuation of the deposit already described under California (see pp. 151–3). All the streams that fall from the western slopes of the Cascade Range contain more or less gold in their bars. The Clackamas, the Molalla, the Santiam, the Calapooya, and the forks of the Willamette, have all been found to contain gold, but only that of the Santiam has been worked. The gold of the Blue Mountains occurs in quartz veins traversing an isolated mass of slate some 60 to 70 miles east of the Des Chutes River. It was worked for a time, but without paying results. The Snow and Puebla Mountains, extending from Nevada into the south-eastern corner of Oregon, are to some extent gold-bearing.

Pennsylvania.—It has been stated (Scien. Amer., n.s. v. 247) by Eckfeldt, who was principal assayer at the Philadelphia Mint in 1861, that underneath the paved city of Philadelphia, there lies a deposit of clay, whose area probably measures over 3 miles square, and is believed to average not less than 15 ft. in depth, samples from which, extracted from a central position at a depth of 14 ft., yielded 1 milligramme of gold from 130 grammes of the deposit. As the clay loses 15 per cent. of its weight on drying, it contains *in situ* 1 part gold in 1,224,000; 1 cub. ft. weighs nearly 120 lb.; and as the assay gives $\frac{7}{10}$ gr. or 3c. (1½*d.*) worth of gold per cub. ft., the 4,180,000,000 cub. ft. of clay contain $126,000,000 (26,250,000*l.*) worth of gold, assuming it to be uniformly rich!

Utah.—Bingham Cañon, in this territory, has been the field of placer-mining on a small scale; and considerable amounts of the precious metal were obtained in times gone by from its glittering sands. The supply was, however, uncertain, and rarely very rich; and the diggings were gradually abandoned to a colony of Italians. But the working of auriferous quartz is now attracting attention. The gold occurs in a porous, and generally very soft and decomposed iron-stained quartz rock, which is still, in the lower workings, impregnated with iron-pyrites. The gold was undoubtedly originally contained chiefly in pyrites, and the oxidation of these has left the rock porous and honeycombed, and the gold "free." The decomposition has gone to a considerable depth, the veins cutting across ridges rising nearly 100 ft. above drainage; the pyrites are not wholly decomposed down to this water-level, but, where protected by clay selvages, they are found in parts of the vein, especially along the foot-wall, only a few hundred feet below the surface. The veins are of immense size, 30, 50, and 60 ft. being worked in some places; and there appear to be several beds of this gold-bearing pyritic quartz, separated by beds of barren quartzite. The hanging-wall of at least one vein is porphyry, though the whole question as to the number of beds and their relations to the quartzite and porphyry is still undetermined. The course of the gold-bearing beds is north-east and south-west, and their dip north-west, which, nforming to that of the quartzite, is at 40° to 60°. The ores are said assay \$15 to \$16 (3*l.* 2*s.* 6*d.* to 3*l.* 6*s.* 8*d.*) to the ton, taken from the decomposed portions of the veins.

Virginia.—The following paper was prepared in response to a letter from the author to the Governor of Virginia, requesting information about gold-mines and gold-mining in Virginia:—

"THE GOLD BELT OF VIRGINIA.

"By THOMAS POLLARD, Commissioner of Agriculture of Virginia.

"The Great Gold Belt of Virginia extends from Fairfax county, on the north, to Halifax county on the south, a distance of about 200 miles in length by 15 to 25 miles in width, embracing an area of at least 4000 miles. [A large number of mines have been opened along this belt, particularly in Fauquier, Culpeper, Spotsylvania, Orange, Fluvanna, and Buckingham counties.] More recently alluvial gold has been discovered in Montgomery and Floyd counties, on the lands bordering on Brush Creek. The proportion of gold there is 20 to 75c. (10 to 37½*d.*) per bushel of earth. The largest particles yet found are worth about 50c. (2*s.* 1*d.*). Gold is found everywhere for miles up and down Brush Creek and its tributaries. Later information, says the *Montgomery Messenger*, is that several pieces have been found worth \$1 25c. (5*s.* 2½*d.*). The Gold Belt of Virginia is composed of a series of granitic, syenitic, steatitic, chloritic, and other rocks peculiar to this section, striking north-east and south-west with the belt, and dipping at high angles, or standing nearly vertical. Stratified with these are numerous veins of gold-bearing quartz, seams of magnetic, specular, hematite, and other ores of iron, trap dykes, &c. The gold found in these materials varies in value from \$1 30c. to \$1000 (5*s.* 5*d.* to 200*l.*) to the ton. An average 100 tons from the surface downwards is estimated as worth \$932 32c. (194*l.* 5*s.*). (Report of

Richmond Chamber of Commerce). Assays of samples from the Franklin mine in Fauquier county, made by R. D. Irving, of New York, in 1870, gave for 200 lb. of materials from the veins, an average value of $46 40c. (9*l.* 13*s.* 4*d.*) of gold, and $1 48c. (5*s.* 2*d.*) of silver; in another $72 55c. (15*l.* 2*s.* 3½*d.*) of gold, and 41c. (1*s.* 8½*d.*) of silver; while another gave net $2 32c. (9*s.* 8*d.*) of gold. The mean assays of ten samples was $24 44c. (5*l.* 1*s.* 10*d.*) to the ton of 2000 lb. [Large numbers of mines have been opened along the belt, notably in Fauquier, Culpeper, Spotsylvania, Orange, Fluvanna, and Buckingham counties;] and from these, and gatherings from the surface and soils, $1,662,627 (346,380*l.*) worth of gold had reached the Philadelphia mint up to June 30, 1871. 'If the same skill and capital were employed here as in California, these mines, in the opinion of practical miners, would yield as well as those of that noted gold-producing state. Silver is associated with some of the gold-bearing rocks above enumerated, especially the chloritic slate. Copper pyrites are abundant in all the gold belt. Carbonate of copper is also found.' (Hotchkiss' 'Summary of Virginia.')

"The gold interest of Virginia has suffered much from speculation. A party secures specimens, hurries to Northern cities, gets up a company of speculators, who develop the mine enough to sell to another company of speculators, and so the business has been conducted. In California and other new countries, men who go there to mine have to depend on their daily work for support, and are forced to work systematically and industriously, or fail in supplying themselves in food and clothing. If this had been the case in Virginia, instead of buying and selling mines on speculation, the gold interest would have been in a very different condition. In Virginia the deepest mining for gold has been not over 150 ft., while in California shafts have been opened 1000 to 1400 ft. Dr. Gray's letter following this communication proves conclusively that we have gold-mines in Virginia which will pay liberally if properly worked and managed. The many speculating schemes which have been inaugurated and failed, have made people adverse to believing in the gold belt of Virginia; but now that the gold yield of California is falling off, and capital there invested is not yielding so satisfactorily, capitalists are turning their attention to Virginia, and a fresh impetus has been given to this industry in our State. Professor Silliman, an eminent American geologist, and Professor William B. Rogers, then of the University of Virginia (and who made a geological survey of Virginia between 1843 and 1848), in 1836 made a personal inspection of the gold mines in Virginia, and each published statements of the true character of the veins, of which they formed a very favourable estimate, the average assay of those they examined reaching $165 (34*l.* 7*s.* 6*d.*) to the ton. Since then, Professor M. H. Stowe, now of Washington city, formerly located on the Franklin mine in Fauquier, Va., a practical mining engineer, has made a careful study of the Eastern gold belt, being previously well acquainted with the Western, and has given the results of his observations in the *Mining Record* of New York. Professor Stowe writes to the *Record* 'that Dr. Endlich, of the Smithsonian Institute, had made an examination of the geological formation of the veins in Virginia, and pronounced it to be the same as that of California, on which the best paying mines occur,' and Professor Stowe further states 'that Dr. Endlich confirmed him in the views he had long entertained that the veins were true fissures.' ('Gold Interests of Virginia and the South'; John Tyler in the *Southern Review*, January 1879). We quote further from Mr. Tyler's article: 'Captain Riley, an experienced mining engineer from the Pacific Coast, who made an examination about the same time, and from whom Professor Stowe quotes, says of one of the mines in Fauquier county, Va., that with the advantage of location, facilities for economical working, vast extent, and richness of lode, this property has great intrinsic merit, and deserves to be classed among the foremost gold-mines of this or any other continent.' It is important to notice the opinion of Professor Stowe, concurred in by Dr. Endlich, that we have true 'fissure veins,' instead of sedimentary or deposit veins. This gives greater value, as it promises an almost inexhaustible supply; for in 'fissure veins' the ore increases in richness as you descend, and although the free gold diminishes, yet the sulphurets increase, and the latter can be so successfully worked with the present improved methods, that the additional metallic value far exceeds the additional cost of producing. This has been proven in North Carolina, where they have mined to a depth of 600 or 700 ft. Nowhere else in the East has deep mining been tried. The deepest in Virginia for gold is from 120 to 150 ft. Mr. Tyler, after saying that practical mining engineers who have made an examination of the Eastern gold belt state that the true method for continuous and large yields was deep mining, expresses the opinion that the want of this is a prominent cause of failure. He says: 'It has been the case from Virginia through to Georgia, with the one exception in North Carolina, that mining has been carried on in the majority of cases only to water level, and in only a few cases below 100 ft. * * * Experience proves that the proper system is to go deeper.'

"Many gold-mines have been worked in Virginia from time to time. Want of experience and of proper machinery, want of sufficient depth, speculative investments with no expectation of working them, except enough to get up a company and sell out, with a repetition of this by another company or individuals, have caused failures and suspensions of many of the mines. Then the late civil war caused a suspension of all mining, save iron, coal, saltpetre, and sulphur. Within the past three years the interest has revived, and a considerable number of mines are being worked, particularly in Buckingham, Fluvanna, and Goochland. In some localities the yield has proven quite large.

"In Goochland county we have the Bertha and Edith, Tabb, Belzora, Fisher, Gilmer, Marks, Waller, Moss or Scisson, L'Aigle d'Or; in Fluvanna county, the Tellurium, Bowles, Perkins, Jennings, Fontaine, Snead, Hughes; in Louisa county, Walnut Grove, Slate Hill, Louisa, Profit, Luce, Walton, Morrison, Baker, Tinder Flat, Alley Cooper (the latter contains a considerable portion of silver and lead mixed with the gold); in Buckingham county, the Moseley, Booker, Lightfoot, Allen, Hobson, Rough and Ready, Duncan's, De Sear (or Appleton's), Buckingham, Greeley; in Fauquier, Franklin, Bancroft, Wykoff, Ellis, and perhaps others, and several in Spotsylvania, names not known; in Orange, Vaucluse and Melville. The Tellurium, located partly in Fluvanna and partly in Goochland, has produced the most gold of any of those enumerated. It was worked for many years by Commodore Stockton, and has produced since its first working about $1,000,000 (200,000*l.*), though it was never worked below 120 ft., the depth of the free gold, the sulphurets, now known to be most valuable, having been thus lost. It is this mine that Dr. Gray speaks of at length in his interesting communication.

"Mr. Tyler quotes from Professor Stowe (from a letter written by him in 1873, just after his return from California and Colorado), regarding his estimate of the value of the Virginia mines. He says: 'I am now of the decided opinion that the ores of Virginia are the richest and easiest to work of any I have ever met. I have made over 200 assays of ore from the Atlantic Slope, and have visited in person many of the localities where gold is found, and I speak from facts.' This is a strong opinion coming from an expert mining engineer. Mr. Tyler says that his opinion concerning the value of deep gold-mining is fully concurred in by Professor Stowe, and by Hon. A. S. Hewitt, President of the American Institute of Mining Engineers, who says in his Centennial address, 'the principal reliance of our gold-mining industries for the future must be quartz, and hydraulic or deep gravel-mines. These may be expected to maintain for years to come their present rate of production, if not to increase it.' The same gentleman, in his address, gives a strong reason in favour of our Eastern mines, which are at our very doors, with cheap labour and materials close at hand. Mr. Tyler quotes from Professor Stowe as to the value of the sulphurets—their value in the East as compared with their value in California and Colorado. The former are far richer, and can be easier worked. Professor Stowe says: 'The average yield from sulphurets in California is $91 (18*l.* 19*s.* 2*d.*) per ton; from Colorado, $128 (26*l.* 13*s.* 4*d.*), and from the Virginia mines, $166 (34*l.* 11*s.* 8*d.*), which shows largely in favour of the East. Besides, the cost, he says, of working sulphurets in California by the chlorination process is $10 (2*l.* 1*s.* 8*d.*) per ton, while in Virginia it ought not to exceed $3 50c. (14*s.* 7*d.*) per ton. This difference of more economical working in the East applies to all branches of gold mining, for the average cost of mining and milling in California is between $8 and $9 (33*s.* 4*d.* to 37*s.* 6*d.*) per ton, while in the East it is only a little over $2 (8*s.* 4*d.*).' After speaking of the great value of the copper and iron pyrites in Virginia, he says: 'I do not know of any other section that offers such inducements to capitalists as our gold mines here in Virginia. What has been done elsewhere in saving the precious metals, and utilizing concentrations, can be done here, and with much less outlay of capital. What would cost here in the way of exploiting mines, would cost from $2000 to $5000 (400*l.* to 1000*l.*) in Colorado, Utah, and Nevada. No investments in railroads, manufactures, or farming lands, will pay such large dividends for the outlay as will the gold mines of Virginia, when handled with the proper skill and energy.'

"Professor Stowe, in an article published in the *Piedmont News* (Culpeper, Va., August 30, 1877), says: 'The Placer mines of Goochland county are now successfully worked by the hydraulic process, which is so extensively and profitably carried on in California; and there are several other counties in the State where the hydraulicing could be made to pay well. Much may be expected by the proper employment of this process in Virginia. It can be worked much more cheaply here than in the West. In many places in California, the cost of water alone per year would be a snug fortune, while here it can be had for nothing. * * It has been asserted that hydraulicing will pay a profit in this State if the soil yields 15c. (7½*d.*) per ton, provided other conditions are favourable. I know, in one place in particular, where the soil would yield that much to the pan, and often more. I have seen as much as $4 (16*s.* 8*d.*) washed from one pan of dust and gravel. There is plenty of water not far distant, but for want of capital and brains this valuable placer mine is idle. Its past history would indicate that there are several fortunes in it. The several years' experience I have had in Virginia teaches me the importance of, and the necessity for, a cheaper ore crusher than we have at present. The apparatus should be portable, and not weigh over 200 lb. It should require no expensive foundations, and be so constructed as to be run by horse power, if desired, and crush to the requisite fineness 500 lb. quartz per hour. * * We need also a cheap and effective process for saving the gold after the ore is crushed. This process should be simple, and easily worked by any one of intelligence. The gold mining interests of the "Old Dominion" have been seriously affected by a great many costly and useless processes, which have done much more harm than good.'

"Professor Stowe, in another article in the same paper, describes some of the gold mines in Culpeper, Orange and Fauquier counties (the Vaucluse, Melville, Old Culpeper, Ellis, Bancroft, Kidwell, Waterman, Franklin and Wykoff), and gives the cost of mining and milling at one of these mines at $2 20c. (9*s.* 2*d.*) per ton (the Ellis mine) in Culpeper county, superintended for three years by himself, and then compares it with the Taylor mine in California, where the cost, according to the report of the United States Mining Commissioner for 1875, was for mining and milling $9 95c. (2*l.* 1*s.* 5½*d.*) per ton; and by the same report, the average cost in 27 leading mines in California, mining and milling was $8 26c. (1*l.* 14*s.* 5*d.*) per ton. Describing one of these mines, the Wykoff, in Fauquier, he says the geological features at the Wykoff present the same general characteristics that prevail elsewhere on the line of the gold belt. The country rock is talcose slate, and the strata are nearly vertical. The decomposition of this rock forms the excellent soil referred to. * * After describing the different veins, one of which is 20 ft. thick (the Mill House vein), he says: 'I have made careful analyses of samples, taken by myself from these veins, with the following results: Mill House vein yielded $41 28c. (8*l.* 12*s.*) per ton; Tunnel vein, the ore of same value; from the Slate vein the clean sulphurets gave $89 18c. (18*l.* 11*s.* 7*d.*) per ton; in another vein, known only by its outcrop, the clean sulphurets yielded $623 10c. (129*l.* 16*s.* 3*d.*) per ton; another vein, which contains copper pyrites, yielded of pure gold $30 (6*l.* 5*s.*) per ton.'

"We find in the *Richmond Whig* (August 22, 1876), and the *Mining Record* September 5, 1878), articles from Professor Stowe on the values of the sulphurets of Virginia. He says: 'Nearly all the gold-bearing veins of the State carry the gold in sulphurets, or at least where they have been. In the lower level of our mines the sulphurets will contain at least 80 per cent. of all the gold in the ore, and hence the importance of the capitalist and miner knowing their value in practical mining operations. I have made numerous tests of Virginia sulphurets, and have been taking great pains to get them from every gold-bearing county in the State, in order that I might get at the facts. I have access to the assays of others, so as not to allow myself to be deceived. So far as I can learn, the assays of auriferous sulphurets in this State are higher than the average of like ores in the Western mines. What I mean by "sulphuret" is pyrites of iron, copper, and galena, which are found on the line of the gold belt. No antimony has been found in our gold mines, and some experts deny the existence of arsenic. Only traces of zinc are found, and we have no refractory constituents in our sulphurets that are found in the West.' Professor Stowe gives the analyses of the sulphurets of seven Virginia mines and of seven California mines, the former based on his own experience, and the latter taken from the 'United States Mining Commissioner's Report,' and says 'it will be seen from the above that the average yield of gold from the sulphurets of seven Virginia mines is greater by $75 (25*l.* 12*s.* 6*d.*) per ton than the average of a like number in California. These averages are not from selected mines particularly, but from those whose yield of sulphurets could be ascertained. There are many mines in the States above mentioned that would furnish sulphurets giving a much higher, and some a much lower, yield than the averages above given respectively; but I do not believe the ratio would be much changed. * * It is hard to tell with certainty what will be the metallurgical treatment of sulphurets in this State. Chlorination is the leading process in California, and will probably be introduced here before the close of the present year (1876). [It has been introduced to some extent]. Several other processes for the treatment of gold ores are to be introduced shortly, and among them there may be something as effective as chlorination, and much easier, requiring less chemical manipulation. * * In California the cost of working ores by the chlorination process is about $10 (2*l.* 1*s.* 8*d.*) per ton. In Virginia it ought not to exceed $3 50c. (14*s.* 7*d.*) per ton.' Professor Stowe speaks of assays made by him of the sulphurets of the Home Mine, Appomattox county. He says: 'I have recently made several assays of the Home Mine, taken from newly opened veins, with the following results: Shaft No. 3, per ton, $206 70c. (43*l.* 1*s.* 3*d.*); shaft No. 4, per ton, $261 68c. (54*l.* 10*s.* 4*d.*); shaft No. 5, per ton $219 10c. (45*l.* 12*s.* 8*d.*); average, $229 16c. (47*l.* 15*s.*).'

"Professor Stowe describes a mine in Fauquier county on the Mason tract, opened in 1875, and called the Bancroft Mine. In 1876, when he visited it, they were about to put in operation a Lightning Pulverizer, or quartz mill, and the Lightning Amalgamator. He describes the former, and says the inventors claim a capacity of 15 to 30 tons per day, depending on the character of the ore. Professor Stowe saw the machine operated, and was much pleased with the result. The ore, he says, was rapidly reduced to a very fine powder. 'In comparison with an ordinary 10-stamp mill this one is cheap, its cost being but $500 (100*l.*), and it requires from 6 to 8-horse power only to run it.' He also describes the Amalgamator, and says, 'Should this process prove a success at the Bancroft Mine, it will at once create a revolution in gold mining in the South, as well as elsewhere. Low grade ores can be worked at a profit, where with any other method they would not pay expenses.' This machinery is the invention of Walker Brothers & Co., of Philadelphia. What has been the subsequent success of the pulverizer and amalgamator, we are not advised.

"Gold was discovered in Virginia in 1831, and was confined for a considerable period to surface mining, corresponding to the placer mining of California, and the gulch mining of Colorado. It has been pursued with varying success. We have pointed out some of the sources of want of success, and adduced facts sufficient, we think, to demonstrate that Virginia is rich in gold, and that time and perseverance, with improved methods and improved machinery, will make gold mining here very profitable, and eventuate in making this State one of the most productive gold regions in the world."

The following is Dr. Gray's letter referred to above :—

"RICHMOND, VA., *May* 18, 1881.

"DR. THOMAS POLLARD, COMMISSIONER OF AGRICULTURE, RICHMOND, VA.:

"DEAR SIR,—In reply to your inquiries in regard to gold mining in Virginia, in the interest of Alfred G. Lock, F.R.G.S., I respectfully submit :—

"1st. I am not a practical gold miner, though acquainted with many facts pertinent thereto, having been raised within 2½ miles of the oldest gold-mine in the State.

"2nd. Being more familiar with this mine than any other, I give fuller account thereof, compiling my statements from written affidavits from owners and lessees respectively, since the discovery of the mine.

"3rd. The name of the mine alluded to is the Tellurium Gold Mine.

"4th. It comprises 344 acres of land by late survey. About 320 acres are situated in the county of Fluvanna, and 24 acres in the county of Goochland. It is about 5 miles from the James river at Columbia, on the R. & A. Railroad.

"5th. This mine was discovered by George Fisher, sen. (now dead), about the year 1832; was leased by him, his sons, and Judge D. W. K. Bowles in 1834, and worked continuously and profitably until 1848, when it was sold to Com. R. F. Stockton.

"6th. George Fisher, jun., now the oldest geologist (practical) in Virginia, states in writing (before me) that there are three developed gold-bearing veins on this property, viz.: the big (sandstone), the little, and the middle veins. They run north-east and south-west, and dip at an angle of 20° to 30° east. The average value of the ores for these 14 years is put down at $100 (20*l.*) per ton, the minimum being about $5 (1*l.*), and the maximum $300 (60*l.*) per ton. The vein matrix carrying gold is slate, quartz, oxide of iron (brown), tellurium, etc.; sulphurets exist in abundance, but not to any considerable extent in the three veins spoken of.

"7th. The average estimate of Com. Stockton's work (for 9 years) is put at about $20 (4*l.*) per ton by his underground manager. He worked the sandstone vein almost exclusively, while his predecessors operated the two others.

"8th. The deepest shaft on the place is 120 ft., and there is only one of these. Of the remainder 80 or 90 per cent. will not reach an average depth of 45 ft. (water level).

"9th. The property, until lately, has been idle; but is now leased by its owners (The Columbia Gold Mining Company, Hon. A. M. Keiley, President), to a northern gentleman, for purposes of further development, with partial working of its ores. The last report we had, some three months since, represented that he was saving $7 (1*l.* 9*s.* 6*d.*) per ton from the ore furnished by the sandstone vein.

"10th. Amalgamation has been the plan of saving the gold in Virginia, and is still, generally; but I understand chlorination is being tried upon the Sneade mine in Fluvanna.

"11th. A 10-stamp California mill is in use upon Tellurium, with amalgamated copper plates to save the gold. I believe this plan will lose at least 40 per cent. of the precious metal. Much of the gold in Virginia is very fine, and cannot be saved by amalgamation. Wet crushing is used generally. What we want is a better saving process than yet known to me, unless chlorination shall serve that purpose. To my mind its chief objection is that it is expensive. I should also advocate dry crushing. Upon a good many properties the gold is lamellated, and so thin and delicate that it will be readily carried off by water. To illustrate how readily this occurs with the fine gold in the Tellurium ore, I will cite a single example: Prof. M. H. Stowe, of Washington, D.C., assayed some of the Tellurium ore as follows, viz. the ore was crushed and passed through a sieve, 60 holes per inch, was then agitated in water and allowed 30 seconds to settle; the water was then poured off, filtered, rinsed, dried, and assayed, and gave in gold $38 98c. (7*l.* 14*s.* 5*d*). The aggregate of this, together with the gold which subsided, made the ore worth $88 06c. (18*l.* 6*s.* 11*d.*).

"12th. Value of Virginia gold ores: assay of 50 tons Tellurium ore gave an average of $51 22c. (10*l.* 13*s.* 5*d.*) per ton, the highest being $137 50c. (28*l.* 12*s.* 11*d.*), and the lowest $4 80c. (1*l.*). The best information I can give of the general value of the gold ores in Virginia is to say that the average is somewhere between $5 (1*l.*) and $15 (3*l.*) per ton. The ores are abundant, and I have no recollection of seeing any one from one of our acknowledged gold mines run under $4 (16*s.* 8*d.*) per ton.

"13th. Cost of gold mining and milling in Virginia. I am indebted to Prof. Stowe for the itemized cost of mining and milling in Virginia, which statement he has made up by a carefully kept record upon the Ellis gold mine in Virginia. He concludes his paper in these words: "Total of mining and milling at the Ellis may be put at, per ton, $2 20c. (9*s.* 2*d.*).

"14th. The Virginia Burke Rocker, about which you inquire, is a mere cradle like a closed infant's cradle, made water-tight, open at the top and provided with a perforated sheet-iron bottom (false and above the true bottom), and a chamber below, charged with mercury for purposes of amalgamation. The whole is placed upon rockers for agitation of gravel, etc., with water which is constantly kept pouring upon it. It is a rude fixture, but very popular in Virginia for placer miners, or surface washers.

Very respectfully submitted,

WILLIAM B. GRAY."

Much information concerning the auriferous wealth of South-west Virginia has recently been published by C. R. Boyd, under the heads of the several counties, which may be summarized as follows:—

Montgomery county: Brush Creek.—The south side of the county is marked by Huronian strata. These rocks, mainly micaceous, felspathic, and chloritic, banded here and there with heavy dykes of quartz, trend N.E. and S.W., the length of the county on that side. The decomposition of these rocks through many ages has left the gold which is now being found along the streams. Whether any distinct stratum exists, with well-marked veins of the precious metal, has not yet been fully determined.

The washings so far show the gravel to yield about 33 dwt. to the hand per day, with rude sluice-boxes. The same strata cross the south fork of Roanoke River, about the line between Montgomery and Floyd counties, and ought there, in the deeper gorges, to yield more heavily than elsewhere. Three miles east of Pilot House, more gold has been washed from the gravel and other detritus than at any other point. The gold has been found in surface washings over an extent of country 6 to 8 miles wide, chiefly in quartz dykes in mica-slates alternating with granite, which is occasionally porphyritic. The dip of the rocks is N. here, but on the south side of Laurel Ridge the dip is the other way. Gold has been found in very handsome quantities on Laurel Creek. "The rock ledges near Pilot House are granitic next to Pilot Mountain; near the foot of this mountain, next to Brush Creek, hydro-mica slates come in, showing here and there ledges of quartz, one of which, 6 to 12 ft. thick, holds most of the much-talked-of gold of Brush Creek. Then south of this are the hydro-mica, chloritic, and schistose bands, which are again repeated in Laurel Ridge, giving the gold again."

Floyd county.—On the Floyd county side of the river there is no stream answering in position to that of Brush Creek. Consequently the formation, though containing, no doubt, the same percentage of free gold, is not so concentrated as to be noticeable like it is where a stream of the size of Brush Creek has worn away much of the rock material, leaving the gold in the sands and detritus along it.

It seems that what gold exists is generally very uniformly distributed through the great mass; but there is no reason to doubt that it is concentrated here and there in easily defined veins. These Huronian rocks are known to have such characteristics in other places.

Carroll county.—No well-ascertained information has been obtained, as yet, concerning gold and silver here. Gold is strongly suspected in the Huronian series, occupying the south-western prolongation of the Brush Creek rocks, which are now yielding gold in Montgomery county.

Grayson county.—So important a statement as that there are immense quantities of the precious yellow metal in the county should, no doubt, be made with a great deal of caution; yet such is the opinion advanced here, after an investigation of some length.

That the gold exists in the present rock in sufficient quantities to pay for extraction is rather a premature statement to make, but that the disintegration of these Huronian rocks has, through ages, left paying quantities in the débris and drift among the streams, is confidently believed. The region of Elk Creek participates in this distribution. In all likelihood, a line parallel with the course of Iron Mountain, about the distance from that mountain that Elk Creek Post Office is, clear through the country, would be in a gold-bearing series. The gold, it may be submitted, results from the decomposition of a pyritous quartz and felspathic band, which seems to follow this line, showing with some distinctness, also, on the bank of New River, a few miles above the old Grayson Sulphur Springs, on the line between Grayson and Carroll.

Elk Creek, however, on the north side of Point Lookout, is the district most likely to pay the intelligent prospector.

Ashe county.—The ores taken in Mulatto Mountain, from what has been commonly accepted as the south-western continuation of the Ore Knob lode, yield on an average as follows: copper, 3 per cent.; gold, $2 5c. (8*s.* 6½*d.*) per ton; silver, $2 80c. (10*s.*) per ton. These ores were taken from a vein 5½ ft. thick; but it is barely possible that this vein lies about ½ mile to the north of a point where the Ore Knob vein should be, if continued. Mulatto Mountain is 10 miles S.W. from Ore Knob.

The Copper Knob mine, situated in the Blue Ridge, near the Ashe-Wantanga line, was found, upon a close examination, to agree very fully with Kerr's description, which is as follows: "This is a quartz vein, or rather a group of them; the principal one carrying variegated copper, with a little chalcopyrite, malachite, chrysocolla, specular iron pyrites, together with visible free gold and silver. The vein is a large body of hornblende slate, though the prevalent rock of the section is a grey gneiss, with a strike N. 60° E., and dip S.E. 40°. The vein is a true fissure, with a direction N. 35° W.; dip, N.E. 45°. Dr. Emmons, who visited the mine when it was open, says, 'This is a true vein, and has a perfect regularity in direction, as well as in its walls.' The width is variable, being 18 in. at the surface, and 12 to 24 in. at different depths below ground." The ores, analysed by Manross, gave "gold 1¾ oz., and silver 18 oz. per ton of mixed rock and ores." Handsome specimens of purple copper ore from the centre of the vein, showing much free gold to the eye, yielded about $2600 (542*l.*) in gold to the ton.

Elk Knob copper vein, really in Wantanga county, seems to be nearly at a point where the Peach Bottom continued that way would strike; but it is an entirely different kind of rock from Peach Bottom vein. Elk Knob vein has been well exposed by the owners in several places, and is at different points variable in thickness, in one deep ravine being 7 ft., and at another point 16 ft. thick. The vein seems to be largely composed of mundic (iron-pyrites); but yields fine specimens of grey copper-ore, and copper-pyrites, all mixed with a low percentage of gold and silver.

Washington.—The gold-production of Washington territory was officially stated at "something under $100,000" (20,000*l.*) in 1879.

Wyoming.—Rumours of gold in this territory were current long before the country was settled. The most important gold-mining "camps" have been in Douglass Creek; Medicine Bow Mountains; near the North Fork and Grace Creek tributaries of the Little Laramie; the Centennial district; the Jehu Mountain district; Rawhide Buttes; Running Water; Laramie Peak; along the sources of the Stinking Water, a tributary of the Big Horn, rising in the Shoshone Mountains; on the head-waters of Clark's Fork, on the Yellowstone; in the Red Mountains; at several points along Sand Creek, a tributary of the Belle Fourche; in the region between the Black Hills and the Bear Lodge Mountains; and in Nigger Gulch.

WEST INDIA ISLANDS. *Aruba.*—Upon this island, one of the Dutch Antilles, gold was discovered in 1824–25, and the mines were worked in a very superficial way till 1838. The only method then pursued was washing the dirt brought down the hill-sides by the rains, in which manner, large quantities of free gold were obtained, including a nugget weighing 44 lb. In 1838, the natives were granted free right to mine, and carried on operations in a disconnected and irregular way till about 1854, when the depth of their pits generally required better appliances than they could command. From 1855 to 1867, very little was done, though it has been stated that 10,000 oz. of gold were brought to market in that period. In 1867, a 35-years' lease of all the gold-mines in the island was granted to Francisco Isola, and sold by him to an English company, which, under various changes of name, still enjoys the right.

The formation of the island is chiefly syenite, but clay-slate, porphyry, dioritic slate, diorite, and granite are also reported. These rocks, or a portion of them, are penetrated by numerous auriferous quartz veins. Over 200 such veins had been discovered by their outcrop in 1872, varying in width from a few inches to more than 30 ft. No less than 158 of these have been examined and fully described. Of samples taken from 47 veins, 10 yielded upwards of 1 oz. of gold per ton; 12, from 13 dwt. to 1 oz.; and the remainder, between 2 and 13 dwt. Assays of the samples from the 10 richest veins gave the following results in gold per ton:—Sero Hacha, 4 oz. 15 dwt.; Picaron, 1 oz. 6 dwt. 3 gr.; Matividiri, 1 oz. 9 dwt. 9 gr.; Goldstein, 1 oz. 1 dwt.; Sombrero, 2 oz. 6 dwt.; Bushiribana, 2 oz. 12 dwt. 12 gr.; Casa Blanca, 2 oz. 2 dwt. 12 gr.; Mira la Mar, 1 oz. 19 dwt. 12 gr.

Yet despite the abundance of the precious metal, large sums of English capital have been unsuccessfully applied to the development of the industry. This appears to be due to three main causes—inefficient apparatus, local peculation, and general mismanagement. The 4074 tons of ore treated have yielded 2697 oz. 7 dwt. of free gold (equivalent to 13 dwt. 5 gr. per ton), realising in London 8255*l.* 12*s.* 6*d.* (or 3*l.* 1*s.* per oz.). The tailings resulting from the treatment of this quantity of ore and an additional 843 tons previously worked, are estimated to amount to about 4500 tons; several assays of these average 17 dwt. 11 gr. of gold per ton, bringing the total gold-value of the original ore to about 1 oz. 10 dwt. 16 gr.

Cuba.—Gold was sent to Spain from this island by the early settlers; but the colonists seem always to have preferred wresting it from the natives to working the mines for themselves, and the mineral wealth of the country remains but little developed or even discovered. Auriferous sands are found in the Holguin, Escawbray, and some other rivers; and fine samples have been obtained from the workings of Agabama and Sagua la Grande.

Hayti [*Santo Domingo, Hispaniola*].*—Our knowledge of the gold-mining capabilities of Hayti is due almost exclusively to Gabb, according to whom, almost everywhere the metamorphosed slates carry quartz veins, sometimes barren, sometimes auriferous. These veins are usually small, rarely more than a foot or two in width; although one instance occurs on the Upper Jaina River, where a width of over 28 ft. is attained. In no case is it supposed that these masses are filled fissures, in the ordinary sense of the term. In every instance where a good outcrop occurs, so that its nature can be clearly made out, the quartz is found interbedded or interstratified with the slate, following its contortions, and intimately united on the sides. In other words, they are true veins of segregation. They are most numerous in the vicinity of the injected masses of crystalline rock. They occur also quite abundantly in the whitish talcose rock of the main ridge, as for instance, on the Bonao road, and again, in the neighbourhood of Jamasa. But one strongly-marked feature has been observed to characterize all the veins. Those nearest to the intrusive rocks are always gold-bearing; and those at a distance from them are invariably barren. This has been abundantly proved by innumerable examinations. No vein-mining for gold has ever been undertaken on the island, but Gabb caused numerous analyses to be made of specimens from various localities, always with the above results; and further, as a natural inference, every stream running through the metamorphic rocks in the immediate neighbourhood of masses of syenite carries gold in its sands, while all those running exclusively in the syenites, or at a great distance from them, are without the precious metal. Thus the Nigua and Jaina Rivers are barren at their heads, but immediately on entering the slates they and all of their tributaries are gold-producing. The upper waters of the Nizao, Ocoa, and their upper branches carry gold; while the Majoma, entirely in crystalline rocks, is barren. Not to multiply examples, the same may be said of all the north face of the Cibao range, west of Santiago; while east of Vega in the north, and east of the Jaina River on the south, that is, east of the eruptive rocks, no gold has ever been reported.

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* The island was called Haiti by the Indians, Hispaniola by the Spaniards, St. Domingue or Santo Domingo by the French. Haiti is now the territory of the Haitian Republic in the west, Santo Domingo that of the Dominican Republic in the east. There is at present no integral name for the whole island.—(Stuart, Jl. R. Geogr. Soc., xlviii. 274.)

Almost everywhere in Savana de las Lagunas, a colour, and sometimes a dozen colours to the pan were found. And though, wherever the slates occur in the neighbourhood of the eruptive rocks, there gold occurs in most, if not all, of the included quartz veins, and the streams are always more or less auriferous, Gabb does not think there is sufficient inducement to bring foreigners here with the exclusive object of mining gold. Usually the gravels are not rich enough intrinsically, or where they are, the quantity in any one spot is so limited that mining on any large scale is not likely to be profitable. On the other hand, he does not wish to discourage the detailed examination of the quartz veins. They are numerous; and some of the pieces examined, while not showing free gold, collected by himself as fair specimens, gave returns that would be considered very encouraging in California. Occasionally a vein can be found that, on account of its thickness, extent, general appearance, and result of assays of its quartz, would certainly be opened in California, and there is no reason why it should not be in Santo Domingo.

Still further south, in the savana of Santa Rosa, the gravels with their red sand, angular fragments of quartz, and the little black streaks of iron-sand in every rain-wash, remind a Californian irresistibly of the foot-hills of the Sierra Nevada. They are in places slightly auriferous, and though not probable, it is yet not impossible, that here, if anywhere, spots may be found where hydraulic mining might be prosecuted with success. The small amount of gold in the present bed of the river seems to indicate that the quantity would be proportionately still less when spread over so wide an area; yet the black sand, the invariable companion of placer-gold, is by no means scarce.

West of the Jaina, below the mouth of the Mano, is a hilly region of slates, bounded on the west by the syenites, which extend across to the Upper Nigua. These hills are traversed by numerous dykes, and are full of quartz veins. The slates are an inextricable mixture of green, grey, brown, and black claystones, variously coloured jaspery slates, and some more or less talcose. Among the first, Gabb found, a couple of miles below the mouth of the Madrigal, a black rock slightly arenaceous, very compact and full of white grains. This is certainly a metamorphic shale, and yet, from its appearance in hard specimens, might be mistaken for a porphyritic rock. A similar material was found not rare on the Nigua River. The quartz veins are usually very small, hardly ever over a few inches in width, and seem to be limited also in horizontal and vertical extent. A few, however, can be measured by feet rather than inches, and Spear spent some weeks in making an experimental opening on one nearly 3 ft. wide, to ascertain its character. The result of his excavation was to disclose a vertical vein with well-defined margins intercalated in the shale. The quartz yielded a little gold by the ordinary miner's test of grinding in a mortar and washing the powder. It is doubtful, however, whether the quantity would have been sufficient to warrant earnest mining.

On the ridge overlooking the mouth of the Mano, at the head of two streams called the Anones and Caballo, which unite and run into the Jaina, a mile or more below the mouth of the Madrigal, is the largest quartz vein on the island. It crops out on the top of the ridge, and its down-hill side is so covered with soil and great blocks of quartz, that it is impossible to ascertain its exact width from a mere surface inspection. It is certainly 20 to 30 ft. thick, and may be much more. Fragments of the quartz are found the whole length of both streams. Gold is found in every eddy in their cañons, and Gabb obtained it by washing even the dirt from the hill-sides. The quartz, as it appears on the surface, is more or less cavernous, the cavities lined or filled with peroxide of iron. On crushing it in a mortar and washing it, Gabb obtained bright gold in little flakes. He caused an assay to be made in New York, of a portion which he took with him in 1869; but "the returns of the chemist were so high that I shall not record them here, preferring to believe that either my specimens were accidentally an unfair sample, or that the chemist made some mistake." Apart from this, enough is known to prove that the vein is gold-bearing, and Gabb believes sufficiently promising to warrant further examination.

Not only is this vein auriferous, but many of the smaller ones must contain their share of the precious metal. Over an area of several square miles of this vicinity, the streams yield gold, and the earth on the hill-sides, and even on their summits, contains it. About La Horca, Gabb's party found gold everywhere; and throughout the woods are innumerable pits, often 20 to 30 ft. in circumference and many ft. deep, whence the Indians mined the clay and gravel, and, carrying it to the nearest stream, washed it. It is doubtful, however, if placer-mining could be made profitable on a modern scale. Not that the dirt is not rich enough; but its quantity in any one place is not sufficient to warrant the construction of expensive ditches, and the slow process of carrying the earth to the water in the Indian style is too laborious and costly to be thought of. Although innumerable little streams intersect the hills, none carries sufficient water for sluices. Possibly some of the larger creeks, like the

Caballo, Anones, Jivaná, &c., might pay moderately to wash their channels; but they would be exhausted too quickly to make them an object of attention alone. The women constantly wash gold in the creek-beds, and also in those of their tributaries, using the well-known *batea* or wooden bowl. But they are content with a return of 3 or 4 *reals* (37½ to 50c., or 19 to 25*d.*) a day. Gabb himself obtained in the Jivaná, grains worth as much as 10c. (5*d.*) in the ordinary gold-pan, and saw lumps weighing ¼ oz. extracted by women in the same manner.

There can be no doubt as to the sources of this gold. It is true that it is usually more or less rounded, but a very little transportation among hard stones will suffice to produce this appearance. It is never found far away from or up stream above the quartz veins. Where quartz is most abundant, the gold is also found in the greatest quantities, and where the one is absent the other does not occur. On the hill-sides, the auriferous earth is clearly derived from the decomposition of the underlying slates; and finally gold is nowhere found in those parts of the streams running only in the eruptive rocks, unless a belt of slate crosses still higher up. Nor is it ever found in the earth overlying the syenites. Throughout this region, syenitic dykes are constantly encountered, and the upper half of the Jivaná runs throughout the parent mass, while veins of the same rock crop out in several places in the lower part of its course, as well as at the mouth of the Anones, and in the bed of the neighbouring part of the Jaina. Here is thus a further proof of the theory already enunciated, that the proximity of eruptive masses is the cause of the presence of gold in the veins of this country.

On the Jivaná, there is more than usual variety in the appearance of the syenite. In one place, Gabb found it flesh-coloured, owing to a pinkish felspar; in another, it is dark-grey and very fine grained; and in still another, it is white, with acicular crystals of hornblende. Near there, in the Jaina, towards the mouth of the Anones, there is a small dyke made up of white quartz, white and pink felspar, and with little isolated grains of a black mineral, which Gabb could not determine with certainty; and between the Anones and the river, is another in which the materials are very unevenly distributed, hornblende occurring both in irregular masses and in isolated crystals.

South of this region, the quartz veins still occur in the slates, and on the Susua and Medina Creeks some gold is found; but the eruptive dykes here disappear, and the quantity of gold rapidly diminishes. It is said to be found as far south as the Cuallo, but this requires corroboration. If it does occur there, it is in very small quantities.

In the quartz are nests of purple sulphuret of copper, some of them as large as one's fist, and little streaks and threads of the mineral are not rare. On crushing and washing a sample of this quartz, Gabb found a minute trace of gold. A little gold, hardly worth mentioning, is found above Monte Mates. Secor, Swan, & Co., found :—

	Sample *a*.	Sample *b*: 100 lb.	Sample *c*.	Sample *d*: 9 tons.
Copper ..	20·5 per cent.	19 per cent.	20·5 per cent.	12·5 per cent.
Gold, per ton	$12 80c. (2*l.* 13*s.* 4*d.*)	$10 0c. (2*l.* 1*s.* 8*d.*)	..	$5 0c. (20*s.* 10*d.*)
Silver ,,	10 40 (2*l.* 3*s.* 4*d.*)	13 3 (2*l.* 14*s.* 3½*d.*)	..	1 23 (5*s.* 1½*d.*)
Sulphur ..	..	..	..	25·6 per cent.

Some curious statistics of the gold-production of Hispaniola, taken from Spanish writers of the Middle Ages, are given by Prof. Soetbeer. It is estimated by Humboldt that the total quantity of gold obtained here during the occupation by Columbus and his followers did not exceed 1,000,000*l.*

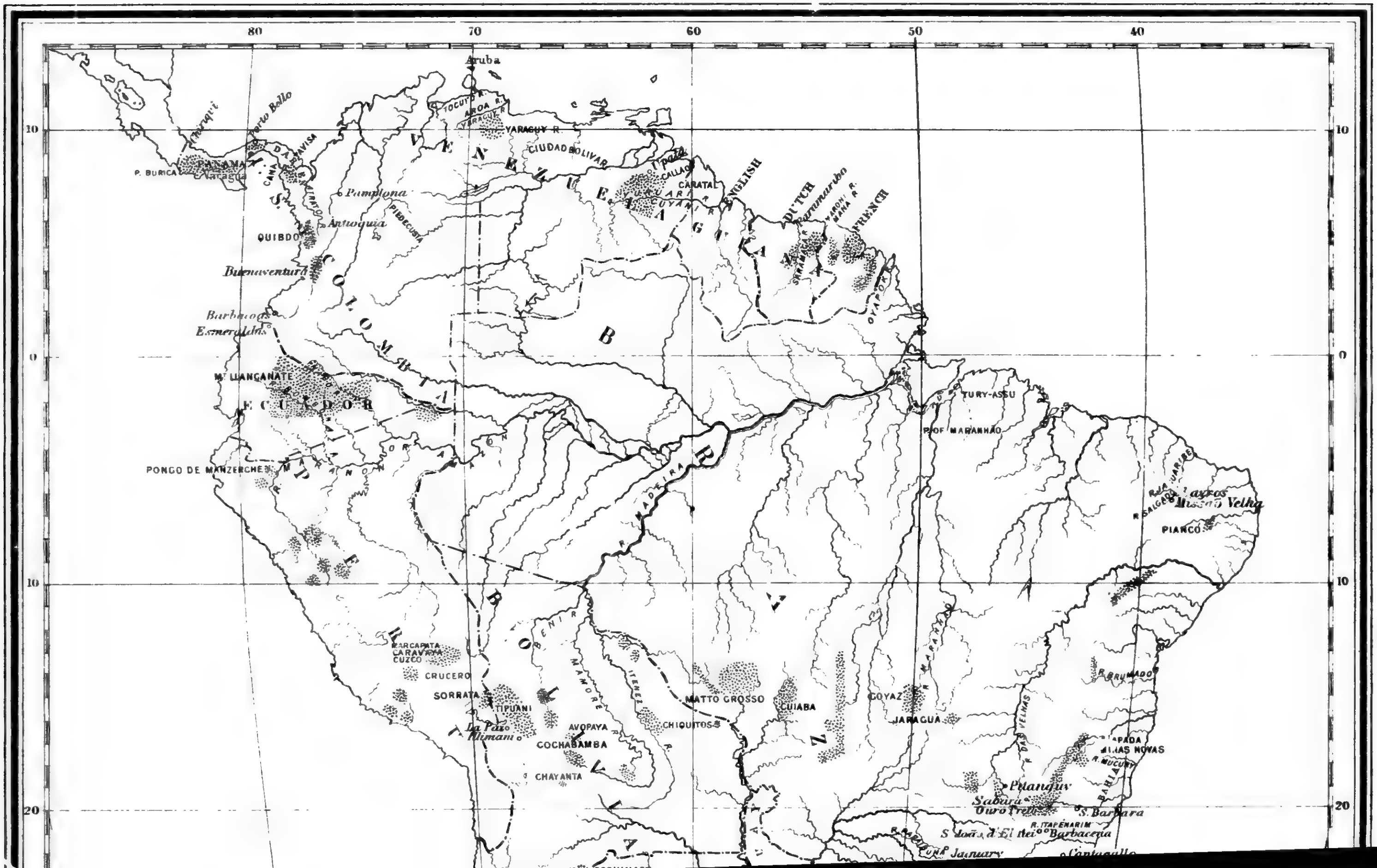
AMERICA, SOUTH.

Argentine Republic, or La Plata.—By far the most complete account of the auriferous wealth of the Argentine Republic is given by Major Rickard, to whom much of the following matter is due.

San Luis province.—The mining districts are situated to the north of the capital, the most remote being about 40 leagues distant. Some of the gold-mines here are so irregularly opened and destroyed that they leave no profit upon the working, and are dangerous to those who labour in them. On the other hand, there are many new veins which are still either in superficial working, or abandoned from want of capital and perseverance.

A German was working an old gold-mine in La Carolina in 1865, yielding arsenical iron-pyrites, and a vein of auriferous copper, recently discovered in the department of Santa Barbara, about 30 leagues from his furnace. The ore, a bisulphide, which this vein yields on the surface, holds some 50 per cent. of copper, with $1\frac{6}{10}$ oz. of fine gold per ton; but in depth the vein degenerates into red oxide, with silicate of copper and iron; and at 11 fathoms in the vertical shaft, it becomes an almost pure oxide of iron, holding only 5½ per cent of copper and $\frac{3}{10}$ oz. of gold per ton. In some pieces of the ore, native gold is found in little specks and thin laminæ; but on assaying a general sample from a large heap, it becomes manifest that the gold is not disseminated in the mass, but only exists as isolated specks. Rickard suspected that this vein, called La Angelita, would eventually become worthless, degenerating into auriferous quartz holding very little gold, but adds in a subsequent note that it "became rich sulphides."

The Rio Quinto (here called Rio Grande) has its source at La Carolina, and its sandy bed exhibits for many leagues striking indications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R. ITAPEMARIM
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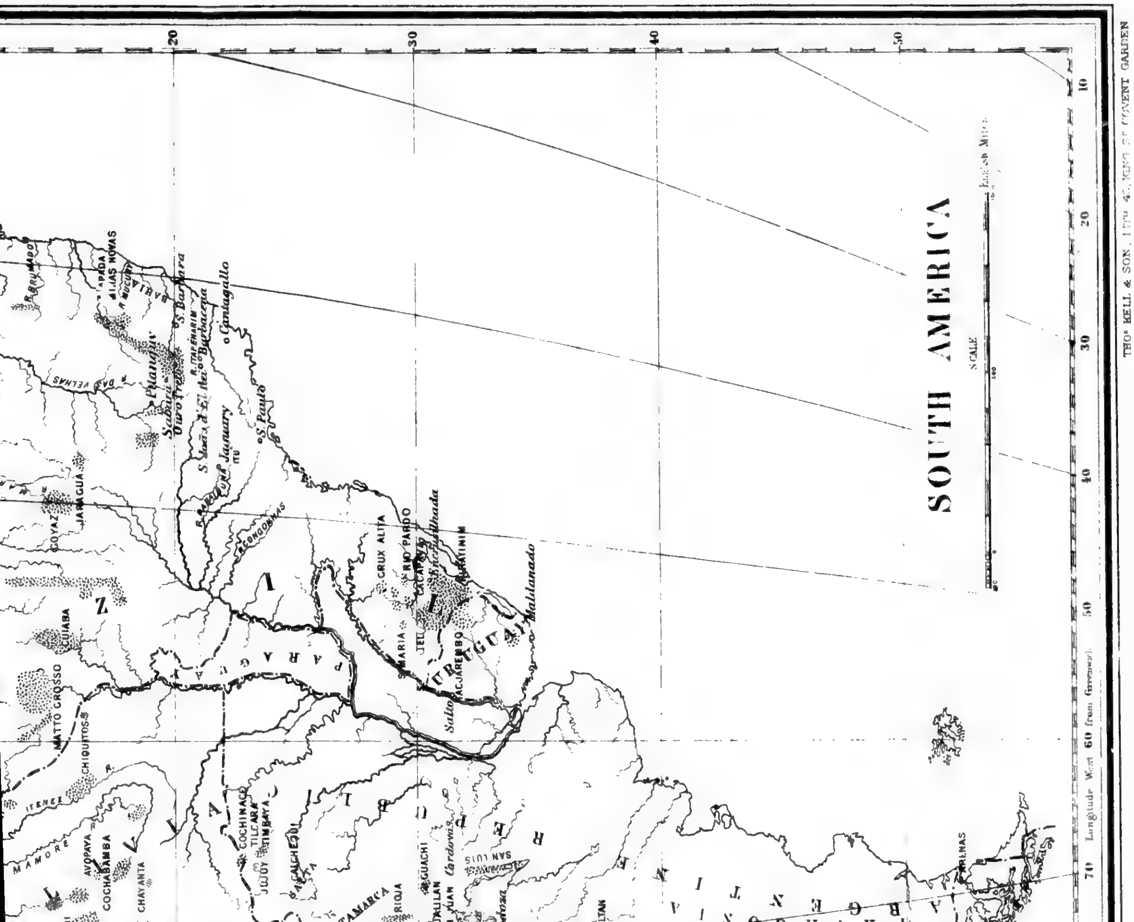


THOS KELL & SON, LITH 40, KING ST COVENT GARDEN

of gold. The districts of La Carolina, celebrated for their auriferous wealth, are as follows:—

La Cañada Honda.—Following almost the same route northward from the capital, and passing through El Trapiche and Levingston's works, the Sierra is penetrated, and Cañada Honda is reached at about 20 leagues from the city of San Luis. Here, at 4126 ft. above sea-level, the first gold-placers are found. The Cañada (a valley) runs north-west to south-east, over a league in length, by 175 yd. in average breadth. At the entrance are situated the washings of Gonzalez Otero.

Formerly the placer miners were unable to work at any great depth, from the invasion of water, which issued very copiously precisely at the part most productive in gold, a depth of 8 to 10 yd.; but one of them, Mauricio Morales, succeeded at length in partially overcoming the difficulty. He sought a lower level at the foot of the Cañada, and from that point excavated a canal, pushing his way through the rocks until he effected communication with the auriferous deposits situated higher up. He covered this canal with flags, leaving a conduit beneath, by means of which the workings in the auriferous beds above are to a great extent drained of their water.

During Rickard's visit, two placer-washings were being carried on; one by Otero, and the other by Morales. The system of washing is by long-toms with riffles, 50 ft. long, 15 in. wide, and 8 in. deep, fixed at an angle of 10°. The auriferous bed lies at 24 to 30 ft. from the surface, and the superincumbent strata are:—(1) alluvium, 4 to 8 ft. in thickness; (2) beds of yellow marl, mixed with alluvium, 8 to 12 ft.; (3) a bed of black sandy clay, 4 to 5 ft.; (4) yellow auriferous sand, with particles of the primary rocks which form the surrounding mountains, 3 ft.; (5) bed-rock, consisting of mica-schist, gneiss, and granite, with felspar and talc.

A stream of clear water runs on the surface, and is utilized for two purposes. First, it is led by small channels in different directions, and made to pass over terraces each lower than the other. About 1 yd. in depth of this upper stratum is broken down by labourers into the water, by which it is carried away, and this is continued until the overlying strata are got rid of, and the auriferous deposit is eventually reached. A single labourer can in a day remove about 320 cub. yd., and he is paid at the rate of *2l.* 10*s.* per month, without maintenance. Secondly, when water is abundant, another canal carries it to the long-tom or sluice, placed as described, and suspended at about 10 ft. above the auriferous bed. Two men with long-handled shovels heave the yellow earth into the sluice, where it is carried over the riffles by the water with considerable force. All the coarse gold is caught by the riffles, but much of the finer particles must undoubtedly be lost. Two men can pass 25 tons of auriferous sand through the sluice in a day; and on the average they extract 4 oz. of gold. From the approximate calculations Rickard was able to make, he does not think that the yield generally exceeds 4 dwt. of fine gold per ton; but there are parts extremely rich, from which two men have extracted as much as 1 lb. of gold in one day. Morales informed him that, during the 6 years he had worked there, on a very restricted scale, he had extracted about 1600 oz. of gold, at a cost of about 216*l.*

Taking the extension of the Cañada yet unworked at 8700 yd. in length, with an average breadth of 25 yd. in the part where the gold is found, and the auriferous bed at 1 yd. in average thickness, there are 217,500 cub. yd., which, at about 30 cwt. per cub. yd., would yield a total of 326,250 tons; and this, at 4 dwt. per ton, is equivalent to 50,976 oz. On account of the low percentage of fine gold (720), this can only be estimated at 2*l.* 14*s.* 2*d.* per oz., and would therefore produce a total value of about 138,000*l.* The stream is insignificant in winter, and is sometimes frozen up; in summer, it is more abundant from copious rains, and large reservoirs might be formed with facility.

In the mountains enclosing the Cañada Honda are many auriferous quartz veins, superficially scratched by the old miners, but none being now worked. Water invades the workings at a short depth; and the ores being in some cases pyritous (arsenical iron-pyrites), the gold cannot be fully nor easily extracted. These lodes were rich on the surface, according to tradition; and there is reason to believe that such was the case, for the auriferous deposits in the Cañada below can have had no other source.

La Carolina.—From the placers of Cañada Honda, the road takes a westerly direction, passing through the chain of hills which divide La Carolina from the Cañada, at 4903 ft. above sea-level. At a distance of about a league, is a Chilian mill, erected by Antonio Schmidt and Co., grinding about 1¼ ton of ore in 24 hours, and fitted with gratings of 2500 holes to the sq. in. The ground ore is carried through a sluice about 50 ft. in length, and the tailings are discharged into a vat, whence they are removed at convenient intervals.

At the end of every week (according to the run of the ore), the riffles are removed from the sluice, and nearly all the gold present is found in the first 4 yd. from the mill. The gold is always more or less mixed with iron-pyrites, and this mass is thrown back into the trough of the mill with mercury, to extract the gold by amalgamation. In a few hours, the gold (partially) unites with the mercury, in which state it is taken out, carefully washed in wooden dishes, strained through canvas, and distilled; the gold is generally of a fineness of 835, or 20·04 carats. The ores being reduced at the time of Rickard's visit were extracted from the principal lode of La Carolina, called Piñiera, which was not then in *beneficio* or productive ore. Nevertheless the bulk of the vein-stuff yielded 1·66 oz.

per ton, of which nearly ½ oz. was left in the tailings thrown out from the sluice. The gold being combined with iron-pyrites, and very finely disseminated throughout the mass, the apparatus employed was incapable of extracting more. All these ores also hold an appreciable quantity of silver, varying from 14·8 to 37 oz. per ton.

About a league north of the reducing works are many old, abandoned mines, situated on the principal vein of La Carolina, which runs from north to south, and is traceable for a distance of nearly half a league, having an average width of about 1 yd. This lode is very irregularly worked on the surface, and probably to its lowest depths; the deepest shaft on the vein is about 55 fathoms. The workings rehabilitated by Schmidt and Co. consisted of an adit, driven so as to cut the lode at a right angle at a good depth, and at the same time to drain the old workings, which were found in every case to be inundated. The lode where cut was a good yard in width, but yielded only the percentage of gold previously stated. Rickard was assured by the owners that the return of gold from the pyritous ores was 5 to 7 oz. per ton.

North of this adit, is an old and very important mine. A well-driven adit, on the level of the bottom of the ravine at the foot of the mountain, was about 120 yd. in length; and the vein, in Rickard's opinion, should be cut at about 40 yd. further on, and at a depth of 50 fathoms from the surface; and he believes that this enterprise, if carried on, would yield good results. The mine in the first place would have to be drained, when a rich portion of the lode would in all probability be laid bare under certain parts, which on the surface present the appearance of having been formerly very productive. This, however, would entail the expenditure of a large sum, owing to the scarcity of labour and fuel, and other drawbacks inherent to the district. The vein is at an elevation of 4243 ft. The only mine in actual work on this vein at the time of Rickard's visit was Schmidt's, and in it only 10 men were employed, while the capital invested did not amount to more than 800*l*.

Towards the north-east from the village of La Carolina is another mine, on a different lode, running from east to west, and which is about ¾ yd. in width. The vein stuff consists of arsenical iron-pyrites, mixed with galena and blende. This mine, called Mercedes, belongs to Levingston. The vein is irregularly and badly worked. At present the ores are raised by means of a vertical shaft, about 10 fathoms deep in water, and exceedingly dangerous from the unsafe state of its walls. There were about 18 tons of ore on surface dressed, of an average assay of ⅝ oz. gold per ton; 6 men were employed.

In addition to these fixed works on the veins, 3 men and about 20 women are engaged in erratic and superficial operations in various parts of the Cerro of La Carolina. These also make a living by washing the sand and earth in the ravine, and on the margin of the stream, from which they extract a fair quantity of gold. In the little village of La Carolina are 17 houses, with 50 inhabitants, who, properly speaking, constitute the whole population. At Cerro Blanco, 2 leagues to the east, are a few small huts, and about 20 inhabitants occupied in washing operations, but here with indifferent success.

The gold-produce of La Carolina, including that of Cañada Honda, from fixed and erratic operations, is about 160 oz. per month, the value of which may be calculated at about 500*l.*

The geological formation of the district about La Carolina principally consists of mica-schist, with gneiss, syenite, talcose and felspathic rocks, and is consequently most favourable for auriferous deposits.

To the south of the Fort of San Rafael, on the banks of the Rio Colorado, are the celebrated deposits of auriferous copper in the Cerro de Payen. It would be important to organize an expedition for the exploration of those districts, but this could only be carried out with a large armed force, on account of the Indians.

In the eastern part of the Paramillo, and close to the high road from Mendoza to Uspallata, there are many veins of auriferous quartz, formerly worked by the Spaniards, and even by the Indians, for their peculiar old grinding-stones or *marayes* are strewn about. The workings are however now choked up, and may be said to be worthless; the veins are narrow, although some were extremely rich in former times. Some 4 or 5 miners were working in 3 of these mines, but only extracting fragments of ore from old shafts and levels; these ores hold 7 to 10 oz. of fine gold per ton, but the quantity is so insignificant, that it can only afford a miserable existence to such men. There is no water nearer to these old mines than at a distance of 2 leagues down this valley, and that so trifling that it scarcely affords sufficient for the necessary domestic use of the workmen.

Gualilan.—This gold-mining district is far-famed for the quantity of the precious metal extracted during the period of Spanish colonial rule in South America. It was discovered by a muleteer, named Juan Suarez, in the year 1751. Returning from a visit to Chili, he lost a loaded pack-mule in the neighbourhood, and, on seeking for the animal, found it resting on the spot now occupied by the Pique mine. To drive on the mule more conveniently, this man took up several stones, and placed them in his leather apron; but was so struck with the great weight of one in particular, that he determined to keep it for further inspection. On his arrival at San Juan, he consulted with a friend, and they discovered the stone to be impregnated with metallic gold. They immediately sought out the place at Gualilan, and enriched themselves before others knew of the discovery. Soon, however, this became known; hundreds flocked to the spot, and after a superficial search, discovered many mines, which yielded large quantities of gold, until the great drawbacks to all mining enterprises in South America—flooding and revolution, interrupted their prolific labours. The War of Independence came, and all was left.

There are 3 lodes, but only 2 were worked. These are 6 to 60 ft. in width, and occasionally, when they join, and are walled by elvan courses, yield quantities of gold. Their direction is nearly N. and S., dip 43° W., and they are visible on the surface for a length of about 4000 yd. The hills in which they are situated are detached from the principal chain of the Tontal range, of which they are spurs, and are composed of limestone. The veins are accompanied, and at parts traversed, by elvan courses, which improve the yield of gold where they come into contact with the lode. There are 14 mines in all (on the same veins), which were worked with great energy for many years after their discovery, until at a depth of about 40 fathoms, more or less, they were inundated by water, and the lower works had to be suspended.

The vein-stuff extracted from the lodes is properly silver-ore, holding chlorides of this metal, but with other combinations, which render it extremely rich in metallic gold. There are large deposits of arsenical iron-pyrites, holding a fair percentage of gold; but the former miners of the country were unable to extract the whole amount, and, as it caused a considerable loss of mercury in the amalgamation process followed, the greater part was left in the mines, or thrown aside as useless. The quantity of this refuse ore is immense, and may be estimated at thousands of tons, intermingled with earth, stones, &c., but all of which holds gold in the proportion of not less than 1 oz. per ton.

After exhausting the veins on the surface, and as far down as the water would permit, and leaving the workings choked up, the mines were abandoned by the original owners. Others followed, however, by whom new works were established; and a vertical shaft was sunk about 40 fathoms, to drain the mines at their greatest depth. But the means thus employed were entirely inefficient, and the mines were successively abandoned and renewed by new adventurers, who expended their limited resources and capital without securing any return for their money. One of the last to undertake the task, Vicente Oros, during the few days that he was able to keep down the water level, and to work at about 4 fathoms below it in the main shaft, extracted 12 tons of ore from an old level or gallery, the assay of which for gold was 5 oz. to the ton. He employed 4 men and a foreman, working with 4 horses and two large buckets geared on to a whim, and in this way 750 gal. of water per hour were taken out; but this is of course inadequate, and cannot keep down the water so as to admit of working in the lower galleries.

One of these old mines, La Misnata, not many years ago, yielded ores holding 96 oz. of gold and 4933 oz. of silver to the ton.

Guachi.—At 12 leagues north of the town of Jachal, in the high range of mountains to the west, is situate the celebrated mining district of Guachi. The road to this place is almost impassable either on foot or horseback. The cone-shaped mountain where the mines are is 12,200 ft. above sea-level. The mountain is isolated, and stands in the midst of a circular cordon of others, also of great altitude, and frightfully steep and rugged. It is traversed in all directions by veins of auriferous quartz, and horizontal beds holding more or less gold.

The name of this mountain is an Indian word *guachi*, signifying the "mountain of gold"; and tracing thus the origin of Gualilan, Rickard finds it also indicates the existence of the precious metal, as it means the "land of gold." The prefix *gua* in the Huarpe tongue signifies "gold," and wherever the name is found, there are sure to be old gold-mines or placer-washings, worked by the aborigines, and doubtless still rich if modern appliances were brought to bear upon them.

The mines in Guachi are old and much worked, and according to tradition, a very large quantity of gold has been taken thence. The principal vein runs N.N.W. to S.S.E., and in some parts is 30 ft. and in others 60 ft. in width, including an enormous centre wall of quartz and elvanite, which also contains more or less gold. The lode is visible on the surface for a length of over 100 yd., but the works are choked up in consequence of a great landslip which took place many years since. This large vein is formed by the junction of two others, the Risco and Potro, which in their turn are traversed by veins containing arsenical iron-pyrites, almost at right angles; the lode is in *beneficio* at the points where these crossings take place. From assays of ore-stuff taken from different parts, Rickard found the gold generally did not exceed 1 oz. per ton.

Thousands of tons of ore undoubtedly exist in the old subterranean workings, but the local difficulties present almost insuperable obstacles to their profitable working. In the first place, it would be impossible to get machinery to the foot of the mountain in the present state of the roads; and in the second place, there is neither wood nor water at hand to supply the requirements of extensive operations in the mines, which are now almost entirely abandoned. Rickard only found 4 men, who were employed in quarrying stones for the construction of a grinding-mill, about to be erected by José Maria Suarez, with the intention of amalgamating the picked ores from the old mines.

At the foot of the mountain, water is found in considerable abundance, but is highly charged with the sulphates of copper and iron, and consequently almost worthless for machinery, as the copper in solution would corrode all the ironwork with which it may come in contact, and would soon destroy the wood as well; neither is it potable. In the narrow and short ravine at the foot of the mountain, are some placer-washings of more than average richness. Here the same earth and gravel is washed year by year after the rains, with almost equally favourable results. This proves that the gold comes from some surface veins above, being carried down by the rains, and accumulated in the sands at the bottom. The geological formation of the mountain is favourable for gold, being mica-schist, gneiss, and syenite. Hornblende predominates, with crystallized felspathic rocks. Potable water is obtained at a short distance from the mines, but it is very limited in quantity, and not of the best description.

After the rains, the poor people in the neighbourhood wash the earth in the bottom of the ravine, and sometimes find small nuggets of gold; and from this and other indications, there would seem to be no doubt as to the existence of a vein or auriferous deposit on the slope of the adjacent Sierra, whence these pieces of the precious metal proceed. Despite every effort to obtain information, Rickard could hear of no such deposit, nor discover whence so much gold is annually derived. He was not able to gather any data as to the yearly production of gold by the placer-washings.

Famatina.—An auriferous district is situated about 7 leagues from the town of Famatina (chilecito), in the Cerro Negro, at 10,250 ft. above sea-level. There is a total absence of firewood, but abundance of water and pasture. It consists of auriferous lodes, the principal not exceeding 3 in number, much exhausted. Their deepest workings are about 30 fathoms in vertical depth, and are full of water and débris. The lodes vary in width from half a yard to a yard; and almost all of them consist of arsenical iron-pyrites, holding a considerable quantity of gold, which cannot, however, be extracted by the crude systems of amalgamation practised in those regions.

The black oxide of manganese and iron abounds, and considerable quantities are lying about on all sides. A sample of these ores, taken without selection, assayed 6 oz. of gold to the ton, a yield which would make the extraction and reduction of the ore very profitable; but, owing to the difficulties of transport, the result of any enterprise in this direction would be extremely problematical from a commercial point of view. The greater part of the veins are very narrow, and their working on a large scale would not be sufficiently, if at all, remunerative.

La Mejicana.—The Rincon de la Mejicana mine was formerly worked for gold. It has been recently opened by Carlos Angel, but the vein had not been cut in *beneficio* when Rickard visited the mine.

The Verdiona mine, which was also renowned for its richness, is now choked up with débris, and has been abandoned for many years. Rickard was unable to enter the galleries or workings, for when mines have been abandoned a few years in La Mejicana, their entrances become filled up with snow and sand from the surface, forming a frozen mass for 10 or 12 yd. down, and of such hardness that it cannot be broken without blasting. As a consequence, mines are soon choked up and their entrances completely obstructed. There is a large quantity of ore on the surface, principally arsenides of iron, from which Rickard took a sample, yielding about 46 oz. of silver (with gold) per ton; also traces of copper, but none of nickel, which these ores are believed to contain.

The Compañia mine, next after the Verdiona, belongs to Vicente Gomez, and was in active operation. There were 13 men employed, and about 6 tons of ore were dressed on the surface, the second class holding 209 oz. of silver and about ¾ oz. of gold to the ton. The first class ore gives 1529 oz. of silver and 1⅓ oz. gold to the ton. The vein is the same as that on which the Verdiona mine is situated, and being in active work, Rickard had the opportunity of inspecting the lowest levels and seeing the lode in depth. It varies in width from ⅓ to 1½ yd.; it contains a large proportion of arsenical iron-pyrites, with a poor assay for silver and gold. The lode, nevertheless, promises well at a great depth, and a marked improvement is observable in it from the surface to the lowest levels. These are not, however, over 20 fathoms in vertical depth.

There is a large quantity of poor ores on the surface, holding a fair percentage of copper and some gold, which, perhaps, might be profitably reduced in suitable furnaces, and produce copper regulus holding gold and silver, if mixed with ores having a good percentage of these metals.

The Upulungo mine is contiguous to the Compañia, and belongs to Ricardo Valdez. This mine is said to be very rich, but its mouth being choked up with débris and snow, Rickard was unable to explore it internally. The owner of the Compañia had commenced a lawsuit against Valdez for having penetrated from a lower level in his mine into the vein of the Compañia, where ores holding a large percentage of silver and gold were extracted. The mine had not been worked for over a year.

There are 5 other veins or mines in La Mejicana, all of which are out of work, and so choked up with earth as to prevent any internal exploration. Their importance is manifest from superficial appearances, and they are almost identical with those of La Compañia. Without exception, they have all been worked upon the surface only, and none of them carried deep enough to prove their ultimate richness.

An adit to cut all the veins of La Mejicana has been started on a level with the bottom of the ravine. This is a very important, but ill-directed, undertaking. The mouth of the adit is at a distance of about 100 yd. from the Compañia mine, and at a vertical depth of 80 to 90 yd. from the surface of the latter. It is 10 ft. high by 6 ft. wide, but badly constructed, tne main wooden props having already broken and given way, owing to the great weight of the superincumbent earth and stones. Not more than 23 yd. of it remain open, the total length being about 50 yd. The expenditure on this enterprise was about 8500*l.*, but the work done does not represent a higher sum than 2500*l.*

Rickard does not consider the direction of this adit to be the true or best one for cutting all the veins of La Mejicana; but, at the length of 100 yd. inwards, its course might be altered, taking two angles, one to the left and another to the right, by which means many gold and silver veins would be cut; for, at a short distance lower down in the ravine, are found old gold-mines of good assay when formerly worked. These are now choked with earth and water, but the principal lodes go into and bury themselves in La Mejicana, and it is therefore very probable that they would be cut by the adit.

About 5 leagues lower down in the ravine are some old placer-washings; but they are now without commercial value, unless worked on a large scale, as is done in California, that is, washing 300 tons a day.

The lode of the Restauradora mine is on the average 7 ft. in width, and the mean assay for copper is 18 per cent.; but the ore also contains silver in the proportion of about 27·13 oz. per ton, and $\frac{1}{8}$ oz. of gold. It is the presence of the precious metals which renders the reduction of copper-ores at all profitable, as this latter alone barely covers the cost of extraction from the mines, reduction, freight, and other expenses incurred previous to its sale in Europe. It is in such cases as this that the want of good and cheap means of conveyance from the interior to the coast is most severely felt, for the profit is absorbed in charges for transport.

The ore-stuff on the surface consisted, at the date of Rickard's visit (March, 1869), of 450 tons of first class ore, holding 20 per cent. of copper, and 600 tons of second class, holding only 12 per cent. of copper, but richer in gold and silver. The ores are sulpho-arsenides, with antimonides of copper and iron, or what are commonly called black, grey, and yellow sulphides, with purple or peacock copper-ore. About 270 tons per month are raised and dressed for the furnaces.

The mine is worked by galleries, winzes, and shafts. An adit, with tramway and waggons, communicates with the upper workings, and discharges the ores into the ore-yard on the surface; but there is another adit lower down, at the foot of the mountain, on which they had been continuously at work for 4 years, driving night and day, to effect communication with the upper workings and drain them. It is 360 yd. in length, with a tramway; but 15 months' work was still necessary before it could reach the desired point. When this is accomplished, however, the mine will be freed from water, presenting a vertical depth of 125 fathoms in virgin ground, which can then be worked without difficulty or impediment. While this is being done, ore of a suitable class exists on the surface, and will be obtained from the upper workings sufficient to keep the furnaces going at the rate of 100 tons a month for over a year.

Carranza, Molina, & Co.'s mines.—The Rosario mine is the oldest in the district, and is energetically worked, with galleries and shafts, and a spacious adit, at 75 fathoms vertically from the upper surface of the mountain. The miners are working 40 fathoms lower than the adit level, and at this depth a considerable quantity of water makes its appearance. Nevertheless, it is easily removed by means of hand pumps. The lode is very variable in width, being in parts 18 ft.; but the average does not exceed 3 ft. The assay of the ore is higher than that extracted from La Restauradora by Lafone, but it is less abundant. Still, from its superior assay, almost an equal quantity of copper is produced. All the ore-stuff raised during the year held on the average 20 per cent. of copper, 19·16 oz. of silver, and ½ oz. of gold to the ton. The vein in the lower levels was in good *beneficio* when Rickard saw it, and promises to improve.

The Mejicana mine is on a large vein, 8 yd. in width, of ferruginous ore, formerly worked for gold. When Rickard visited this mine, an adit was being driven on the vein, but had not yet reached good ore. He was afterwards informed that good *beneficio* was subsequently cut.

The Esperanza mine belongs to the same owners. The vein is 1 yd. in width, holding 30 per cent. of copper, in carbonates, oxides, and sulphides, with a higher assay for silver and gold than the Rosario. A vertical shaft was driven, and a whim had recently been constructed to raise ore more economically. Good results are certain to be obtained in working this lode in depth.

Ores from the Rosario have frequently a high assay for gold, and sometimes native gold visible in specks on the surface. In many instances those ores hold 70 per cent. of copper and 5 oz. of gold to the ton; but when a quantity of this percentage is obtained, they are remitted direct to Europe without reduction, and leave a large profit.

Argentina [*Ojo de Agua*].—Very wide veins of auriferous iron-ore, which ought to hold a proportion of gold, exist in the neighbourhood.

Guayco.—Auriferous ores are said to exist in the adjacent mountains; there are many open superficial workings on quartz veins, in some of which native gold is visible.

A report by Ford, a former Secretary of Legation in the Argentine Republic, states that the mines in the province of La Rioja contain gold. They are considered amongst the richest in the Republic, particularly those situated in the district of Famatina. The mines in the province of San Juan contain gold. El Morado is the name given to a mine from which gold is extracted, yielding on an average 10 oz. of the precious metal to the Spanish ton. Gold and silver are also met with in the district of Tontal. The province of Mendoza is rich in gold-mines; and in that of Catamarca copper is largely extracted, containing a considerable quantity of gold.

Captain Andrews (1827) mentions the *lavaderos* (alluvial gold-washings) of the Rinconada, and regrets that those of Jujuy, so much spoken of as producing abundance of gold in dust, grains (*pepitas*), and scales (*laminæ*), yielding never less than 23 carats, have been abandoned, without being a third worked, for want of a pump.

A writer in 1830 describes the gold-mines of the Cerro Morado, of the Famatina range, (prov. La Rioja), and the mode of clearing water from the mines by hide buckets, the inefficiency of which has caused several mines of reputed value to be abandoned: (in Mexico, these hide buckets answer well). In the Cerro Morado, vast masses of syenitic greenstone and quartzose rocks are imbedded in, or alternated with, the clay-slate superimposed on the gneiss. The elevations of this Cerro are intersected with broad veins containing a friable and highly ferruginous indurated earth of a composite nature, but exhaling a strong argillaceous odour. This earth contains deposits of auriferous cellular quartz, in which, iron, variously oxidated, but chiefly in scaly oxides, is interspersed, and is apparently the agent in the disintegration going on in the quartz. Large specimens of this quartz, with fine grains of gold here and there visible on the surface, may be obtained; copper- and iron-pyrites, said also to be auriferous, occur in these veins. Veins of pure scaly oxide of iron are also to be met with, and are likewise regarded by the native miners as *creaderos*, or indications of the proximity of gold. Some of these auriferous veins attain the breadth of several yards, and, in 1827, yielded 1 to 20 or more oz. of gold in 50 cwt. of ore. Two of them are worked with profit. Much gold doubtless exists in this district; and it would perhaps not be difficult to extend the present works without risking any great amount of capital. The highest part of the Mejicana (a portion of the Famatina range) is called the Espina, and contains several mines and veins of silver. The ore of this elevation is a black, or greyish-black earthy sulphuret of silver, either pure or more or less dispersed in a quartzose and hornstone gangue, and containing a proportion of gold sufficient to give the silver produced a yellow tinge. The veins of the Mejicana dip 70° to 75° N.E. The inclemency of this region is excessive.

More recent information is contributed by Egerton, Secretary of Legation in 1881, who says that perhaps the best known Argentine mines are those of Famatina, in the Mejicana range, in the province of Rioja. The formation is Silurian. The copper ores of this region yield an average of 27 to 30 per cent. of copper, and there is always gold or silver—generally both—present, while gold in veins is distributed in the ferruginous quartz. As a rule, in this district, the veins are of two classes: in some, there is alternate porous quartz with sulphuret of silver, iron- and copper-pyrites, grey antimonial and arsenical copper, galena, and blende, the mineral becoming more compact and full of sulphuret after a certain depth. Such is the principal vein, the Upulungo and other metalliferous veins are more homogeneous, containing large quantities of grey copper, with some gold, but no silver.

Of the very great richness in ore of the Mejicana range, there need be no doubt. The main obstacle in the way of mining here is the position of the mines, 16,000 or 17,000 ft. above the sea-level, near the summit of the range, the ores having to be carried into the valley by mules, a descent of more than 10,000 ft., the village of Famatina being 5600 ft. above sea-level. The distance from thence to the nearest station on the Cordova line is considerably over 100 miles.

In Jujuy, which is in a very backward state, there is little enterprise and less capital; and silver and gold are sought for in a very primitive manner. The so-called mines are chiefly in the department of Timbaya, Tilcara, and Cochinaco. There is a vein, the Carmen, in the Rinconada, which is said to be very rich in gold. In the province of Salta, during the Spanish times, gold was found and collected in various districts, chiefly in the Calchequi valley.

Gold used in former days to be got at the Gualilan and Guachi mines, in the Pismanti and Jachal valleys. The mines of Carolina, in the province of San Luis, used to be famous, the Sierra of San Luis, near Tomalasta, in which they are situated, abounding in auriferous quartz mixed with pyrites and iron. The mountains of Cordova contain rich silver-quartz veins, copper-pyrites, and argentiferous lead; and the Sierra de la Pumilla appears especially full of gold, the matrix veins of which are chiefly of white, bluish, or rose-coloured quartz. The districts of El Patacon, Bragada, and Caleca, in this range, are the best known in this respect.

According to St. John Wileman (1882), gold-mines are being worked on a small scale and in the rudest manner in the states of San Luis, Mendoza, San Juan, Cordova, and La Rioja. The yield of pure gold obtained from imperfect crushings varies, according to the character of each specific reef and depth of working, from $1\frac{1}{3}$ to 15 oz. per ton of quartz or pyrites. Moreover, the alluvial gold-deposits or "placers" situated in the states of San Luis and Jujuy, give an average yield of $\frac{1}{18}$ to $\frac{1}{4}$ oz. pure gold per cub. yd. of pay-dirt passed through the sluices. "Nothing but capital and honest capable management are required to ensure far more durable and lucrative results from gold-mining in this country than can be anticipated in India, even on the assumption that Indian mines will give as high a yield as their prospectuses indicate."

BOLIVIA.—Though silver is the staple metal of Bolivia, gold in considerable abundance has been found in the mountainous districts; but the mines have not been worked to the extent of their capabilities, owing to the expense of treating the ores. In these lodes, the gold mostly occurs in admixture with antimony, silver, and other substances, necessitating metallurgical processes for its complete extraction. The mountain of Illimani, according to Keith Johnston, is believed to contain great quantities of gold, in consequence of that metal having been found profusely deposited in the lake of Illimani at its base. In the 17th century, an Indian found here, not far from the city of La Paz, a mass of native gold, said to have been detached from the mountain by lightning, and which was sold for $11,269 (1787*l.*), and placed in the Natural History Museum at Madrid. The bulk of the Bolivian gold, however, is alluvial, obtained from the *lavaderos* or washings in the beds of streams, the most productive of which are the celebrated ones of Tipuani, fed by streams from the snow-capped peaks of the Cordillera of Ancuma, about 60 "leagues" north-east of La Paz, in the province of Larecaja. The precious metal is found in *pepitas* or grains 10 to 12 yd. below the surface, imbedded in a clay stratum several feet thick. These washings were worked by the Peruvian Incas, whose tools are occasionally found buried in the alluvion, and almost invariably in the richest spots. The placers and quartz veins of Chaquecamata, in the province of Ayopaya, in Cochabamba, are also famous, and their yield up to 1847 was valued at 8,000,000*l.* Several districts in Potosi, Chuquisaca, Santa Cruz, and Tarija are also rich in gold.

From Humboldt, it appears that the gold minted in the years 1780 to 1790 was of the following value:—

Year.	£	Year.	£
1780	176	1786	120
1781	80	1787	94
1782	110	1788	97
1783	92	1789	?
1784	76	1790	110
1785	81		

Prof. Soetbeer continues it for the years 1791–1803, thus:—

Year.	£	Year.	£
1791	98	1798	231
1792	58	1799	142
1793	88	1800	168
1794	110	1801	175
1795	102	1802	120
1796	143	1803	140
1797	203		

He also gives a recapitulatory table of the silver and gold production of Bolivia from 1545 to 1875, the latter part of which may be translated as follows:—

Period.	No. of Years.	Total Gold.	Yearly Average.	
		lb.	lb.	£.
1545–1560	16	35,200	2,200	139,500
1561–1580	20	35,200	1,760	111,600
1581–1600	20	52,800	2,460	167,400
1601–1620	20	52,800	2,460	167,400
1621–1640	20	44,000	2,200	139,500
1641–1660	20	44,000	2,200	139,500
1661–1680	20	44,000	2,200	139,500
1681–1700	20	44,000	2,200	139,500
1701–1720	20	26,400	1,320	83,700
1721–1740	20	26,400	1,320	83,700
1741–1760	20	26,400	1,320	83,700
1761–1780	20	35,200	1,760	111,600
1781–1800	20	44,000	2,200	139,500
1801–1810	10	22,000	2,200	139,500
1811–1820	10	13,200	1,320	83,700
1821–1830	10	8,800	880	55,800
1831–1840	10	13,200	1,320	83,700
1841–1850	10	13,200	1,320	83,700
1851–1855	5	11,000	2,200	139,500
1856–1860	5	11,000	2,200	139,500
1861–1865	5	11,000	2,200	139,500
1866–1870	5	11,000	2,200	139,500
1870–1875	5	22,000	4,400	279,000
		Total production.		
1545–1850	306	580,800	36,828,000	
1851–1876	25	66,000	4,185,000	
1545–1875	331	646,800lb.	41,013,000*l*.	

The following valuable remarks were kindly prepared by J. B. Minchin, a recent traveller in Bolivia, at the request of the author. They form the most important contribution to the knowledge existing on the subject.

GOLD-DEPOSITS IN BOLIVIA.

"The most extensive gold-region of Bolivia is probably that of the La Paz Cordillera; it is known to extend through the province of Caupolican, and through the Peruvian provinces still further north; but I am acquainted with it myself only south of the 15th parallel. Its southern limit is not definitely known, but it probably extends with some interruptions to the neighbourhood of Cochabamba, where the rich deposits of Chaquecamata have been worked. Gold is met with throughout this region on both sides of the mountains, but the deposits on the north-east side appear to be far richer, both in quantity and quality. On this side, gold-bearing quartz veins are found at great altitudes, and have been imperfectly worked at Yani, a village situated on one of the spurs of the Sorata mountain.

"On descending the deep ravines which slope towards the plains of the Amazon, extremely rich deposits are encountered along the river courses. The *quebradas* of Tipuani and Cajones are notable instances. The gold in these cases is found collected on the bed-rock, usually 25 to 40 ft., and sometimes more, below the river level; also under the *playas* or level banks occurring at intervals. This bed-rock is occasionally composed of more or less inclined slate strata; at other places it is a hard ferruginous conglomerate, no doubt itself overlying the slate.

"In addition to the deposits in the rivers, the hills along each side of the ravines contain in many places gold-bearing strata. These, in the Tipuani quebrada, which I have myself examined, present at some points facilities for being worked by the hydraulic system, by utilizing the water of certain streams which descend from great heights to the main river, and by means of which, employing suitable hose, a vast extent of ground might be washed down at a comparatively low cost. The work has, however, hitherto been almost exclusively confined to extracting gold from the bed-rock below the river, on which it is nearly everywhere met with, at some points in great quantities. The problem has been to reach this depth and extract the water which percolates into the workings. In some cases, this has been done by means of water-wheels, moved by streams brought at considerable cost round the foot of the hills, and working pumps; in other cases, by actually baling the water out, tiers of Indians being employed to pass the buckets from one to another.

"The late Señor Villamil, for many years sub-Prefect of the province, and who had on this account facilities for obtaining Indian labour, worked the Tipuani deposits more extensively than any one else; and though his operations were conducted in a more or less primitive and imperfect manner, it is estimated that he took out nearly $2,000,000 (400,000*l.*) worth of gold. On visiting Europe, when already an old man, and seeing the powerful machinery employed here in mines, he is reported to have exclaimed, in a conversation on Tipuani, 'Con veinte años mas de vida, y la experiencia que yo tengo, que Napoleon, le compraria su Francia!'

"At Chuchiplaya, situated a few miles below the village of Tipuani, a wide pit was sunk with some difficulty to the bed-rock (here about 10 yd. below), and gold-dirt giving 2 and 3 oz. to the *batea*, or small wooden dish, was taken out; but the machinery for extracting the water appears to have broken down, and the work was abandoned.

"The rugged nature of the country on the eastern slopes of the Andes, the want of roads even for mules, and the consequent difficulty of introducing any kind of machinery, has hitherto proved the chief obstacle to the extensive working of the gold-mines. This obstacle will probably be to a great extent overcome when lines of communication are established by way of the Amazon. The high quality of the gold, its well-known abundance, and the many other valuable products of this region, such as cinchona-bark, coffee, and cacao, offer a great inducement for the investment of capital.

"The cultivation of cinchona, which is now becoming of importance in this region, will also have the effect of facilitating communication with the Pacific; the distance, indeed, across the mountains is comparatively short to Lake Titicaca, the steamers on which connect with the Puno Railway, and by this with the sea-coast.

"The climate of the mines is usually good; that of the quartz-vein region, at a height of say 10,000 ft. above sea-level, is particularly healthy. At certain points of some of the low and deep ravines, intermittent fevers prevail, no doubt due to the rank vegetation and to the hardships suffered by all who now go there, from the want of proper food. Almost everything is at present carried on the backs of Indians from the town of Sorata, from La Paz, or from some point bordering on the high table-land; most of the passes across this part of the Andes are at a height of rather over 15,000 ft. above sea-level. Besides the mines of Chaquecamata, gold exists still farther south, through the province of Chayanta, and is met with at the Rinconada on the Argentine frontier.

"Gold-mines also exist in Eastern Bolivia. The Jesuits are said to have worked extensively among the low hills of San Simon on the river Itenez; and an experienced Californian miner, who visited the spot, has informed me that he found rich quartz veins, and took away some fine specimens, which attracted much attention in San Francisco. But here again the want of roads, and the fact of the navigation of the Itenez being cut off from direct communication with the Amazon by the falls of the Madeira, prevents anything being done to work them.

"Further up the Itenez, in the neighbourhood of the old city of Matto Grosso, gold is worked to some extent by the Indians and negroes, who are, however, frequently disturbed by the incursions of savage tribes. San Javier, in the province of Chiquitos, is another extensive gold-region, occupying probably nearly 100 sq. miles of low hilly country. Work is carried on at present in a primitive manner at Santa Rosa, a mining village of some 2500 inhabitants, engaged exclusively in this pursuit. The gold, of a very fine quality, is met with in the wide ravines a few yards below the surface in strata overlying the slate bed-rock; the distribution appears to be irregular, many of the workings yielding well, while others in the neighbourhood are almost unproductive. Not even cradles are employed; the dirt is exclusively washed in small wooden hand-basins.

J. B. MINCHIN, Assoc.-M. Inst. C.E."

The province in which the present city of La Paz is situated was formerly known by the name of Chuquiyapu, which, in the native language, is commonly thought to signify *chacra*, or an "inheritance of gold," and is locally and corruptly called Chuquiabo. Along the valley De la Paz, flows a pretty large river; when it is increased, either by rains, or the melting of the snow on the mountain, its current forces along huge masses of rock, with some grains of gold, which are found after the flood has subsided. (Pinkerton's Voyages.)

On the Llisa and Condormanana hills, near San Andres de Mochaca, veins of gold have been found, as well as in Vilaquil, 18 miles from La Paz, where ancient winnowing-grounds have been recognized (*Nature*, v. 412). Mathews (1878) states that a great deal of gold is found in almost all the ravines forming the head-waters of the Beni and Mamoré rivers (the two principal affluents of the Madeira), and that most of the streams descending to the Itenez, from the Cordilheira Geral, in Brazil, have auriferous sands. Whilst he was in Sucre, a Chilian expedition returned from the Sierra of St. Simon, with very encouraging accounts and specimens of the gold-quartz found there. Orton (1876) alludes to the Beni as draining "the valleys of Yungus and Apollo, rich in gold."

BRAZIL.—Gold occurs in Brazil in quartz veins traversing clay-slates, mica-slates, and other metamorphic rocks, among which is the itacolumite; in certain iron-ores, called itabirite and jacutinga; and in the drift clays and gravels, and alluvial sands and gravels, arising from the disintegration of the former. The most important auriferous district is in the vicinity of Ouro Preto, in the province of Minas Geraes. The only gold-mine yet opened in northern Brazil is at Tury-assu, province of Maranhão. Concessions have been granted for this purpose, in many parts of Bahia, Pernambuco, Parahyba, Piauhy, Goyaz, Ceará, and São Paulo, some of which will undoubtedly be productive. Gold is known at Caçapava, Rio Pardo, Santa Maria, and Cruz Alta, province of Rio Grande do Sul, southern Brazil; and many more localities will be added to the list when this gigantic country shall have been thoroughly explored.

Touching the gold-production of Brazil from 1691 to 1875, Prof. Soetbeer gives the following summary:—

Periods.	No. of Years.	Total.	Annual Average.	
		lb.	lb.	£
1691–1700	10	33,000	3,300	209,250
1701–1720	20	121,000	6,050	383,625
1721–1740	20	389,400	19,470	1,234,575
1741–1760	20	642,400	32,120	2,036,700
1761–1780	20	455,400	22,770	1,443,825
1781–1800	20	239,800	11,990	760,275
1801–1810	10	82,500	8,250	523,125
1811–1820	10	38,720	3,872	245,520
1821–1830	10	48,400	4,840	306,900
1831–1840	10	66,000	6,600	418,500
1841–1850	10	52,800	5,280	334,800
1851–1855	5	24,200	4,840	306,900
1856–1860	5	23,320	4,664	295,740
1861–1865	5	26,400	5,280	334,800
1866–1870	5	19,250	3,850	244,125
1871–1875	5	18,920	3,784	239,940
		Total production.		
1691–1850	160	2,169,420	137,560,950*l.*	
1851–1875	25	112,090	7,107,525*l.*	
1691–1875	185	2,281,510 lb.	144,668,475*l.*	

According to Dietzsch (Min. Jl., xlix. 347), since the discovery of gold in 1693 to the present time, the quantity extracted in Brazil may be computed in round figures at 2,000,000 lb. troy. By far the greatest proportion of this has been derived from alluvial deposits by river washing. Along the Rio das Velhas, and its tributaries, as well as those of the Doce river, there is ample evidence (in gravel heaps, &c.) of the amount of work performed. The principal period of this washing has been from 1695 to about 1825.

The exports of gold from Rio de Janeiro in 1879 were 1,187,638 *milreis* (120,248*l.*) to Great Britain, 2424 (245*l.*) to Germany, 38,830 (3931*l.*) to France; total, 1,228,892 (124,424*l.*); in 1879–80, they were 1,926,306 (195,038*l.*) to Great Britain.

Quitting statistics, the most reliable and exhaustive account of the gold-mines and auriferous gravels of Brazil is that given by Hartt, one of the members of Agassiz's scientific exploring party. He discusses the subject under the heads of the several provinces, as follows.

Rio de Janeiro.—At Cantagallo, during the reign of the first Viceroy of Brazil, gold was discovered by certain seekers and smugglers (*garimpeiros*), who, quietly taking possession of the place for many years, extracted gold in secret, and it was a long time before the Brazilian government discovered the region whence so much gold found its way to the capital. Mawe says that the rock of the locality is granite, composed of felspar, hornblende, quartz, and mica, sometimes holding garnets—evidently gneiss, like that of the Serra do Marto, to the westward. He states that the gold comes from the lowest bed of *cascalho* or gravel, occurring always in rounded grains, and that he never saw a crystallized specimen. Gold and ferric oxide were the only metallic substances found here. At the time of Mawe's visit (1808), so little gold was extracted, that the *quinto* or royalty claimed by the government scarcely sufficed to pay the officers and soldiers appointed to collect it. Von Tschudi says that the gold of Cantagallo came from the bed of a stream. Gold was also formerly washed in Santa Rita, a place about 5 Brazilian leagues north-east of Cantagallo. Mawe describes the gold as occurring in a bed of *cascalho* or quartz gravel, overlaid by earth. The layer of *cascalho* varies in thickness from 2 ft. to 7 or 8 in., and lies under a thickness of 4 or 5 ft. of earth. The Cantagallo region was never very rich in gold.

Espiritu Santo.—In 1723, the first settlers on the Itapémerim discovered gold in one of its affluents on the north, called Rio do Castello. A decree of the 17th September of the following year determined that the auriferous lands should be divided into small portions among all those who wished to employ themselves in the labour of mining, with the condition that they should subject themselves to the laws of the *sesmarias* and to the impost on the gold. A gold-washing town was established at the confluence of the Castello with the Itapémerim; but the hopes of a rich yield proved deceptive, and the *Corografia Brasilica*, published in 1817, speaks of these mines as having been abandoned on account of the incursions of the Indians. It appears that in certain places on the head-waters of the Rio Mangarahy, traces of wash-gold were found; at least the names California de Dentro (in the colony) and California de Fora (on the southern bank of the Rio do Meio) would indicate it.

Minas Geraes.—Gold and diamonds occur in the Serra do Grão Mogor. Spix and Martius, who visited it, describe it as being only about 4300 ft. high. The prevailing formation of this region is quartzose slate. Boulders of white quartz are abundantly scattered over the surface, and contain asbestos. The drift, as well as the sand and gravel of the streams in the vicinity of Sucuriú, contains gold, but in small quantities. Hartt saw a few old abandoned workings. The Ribeirão do Meio is a brook emptying into the Capivary, from whose sands gold has been got.

In 1727, Sebastião Leme do Prado, with a band of Paulistas, travelling northward through the province of Minas, discovered gold in the river Bom Successo, and gave it the name which it bears. He established here regular mining operations, and founded the city now known as Minas Novas, which grew to be a flourishing town. The precious metal was also discovered elsewhere in the vicinity, and in especial abundance on the hills bordering the Rio Capivary, near the Arraial da Chapada, where it was very extensively mined. The gold was principally obtained from the sands and gravel of the river, and from the gravel sheet underlying the drift-clays on the slopes and tops of the hills. Very little gold was extracted from the quartz veins, some of which were known to be richly auriferous. The hills are dry, and water is to be found only in the rivers, which, during the greater part of the year, afford a good supply, so that the washing of the gravels on the high grounds was attended with much difficulty. Ditches or *regas* were dug round the hills to collect rain-water, which was brought into tanks, and in some of the washings all the water used was derived from this source. At Minas Novas and Chapada, washings said to be rich were pointed out to Hartt as abandoned because of the scarcity of water, when 100 ft. below tumbled a dashing stream.

Notwithstanding the disadvantages under which these old miners laboured, a large extent of ground was worked over, and an immense quantity of gold was extracted ; according to one authority, 300 *arrobas* (9711 lb.) were sent to Bahia alone. Many large nuggets were discovered in these mines. In the Lavra do Batatal, a lump weighing 28 lb. was found. In 1746, diamonds were discovered in the vicinity of Diamantina, and Government prohibited the extraction of gold in order to encourage the search for diamonds. This prohibition put a stop to the gold-mining of Minas Novas, and, though the prohibition has been removed, the blow has been fatal, for little gold-mining has since been carried on, and the present (1870) inhabitants content themselves with agricultural pursuits, or help to swell the number of miners who wash for diamonds on the Rio Jequitinhonha. The gold-mines are to-day practically abandoned, but the idea that they were worked out is very erroneous. At Minas Novas and Chapada, the rocks are slates and quartzites, and resemble very closely those of the gold-region of Nova Scotia. Indeed, it was the strong resemblance borne by the slates of Calhão and the vicinity to the Nova Scotian gold-bearing rocks that aroused Hartt's interest, and led him to turn out of his way to visit Minas Novas. These rocks evidently overlie the mica-slates which flank the gneiss of the coast belt, and Hartt believes they will prove to be Silurian in age, perhaps of the Quebec group. At Minas Novas, their strike is N. 42° to 50° E., and their dip is vertical. They are traversed by great numbers of milky-quartz veins, some of which are well known to be auriferous, and are of considerable dimensions.

In an enormous gully cut out by the surface waters in the hillside above the cemetery on the Bom Successo, at Minas Novas, are several fine veins of corrugated quartz, which appear to have precisely the same structure as the barrel quartz of Nova Scotia. These veins run nearly vertically through the rock, and may be beds instead of veins. As they are exposed in the cliff, they present the appearance of vertical fissures, in which, cylindrical masses of quartz are piled in a single row, their ends projecting like logs. Some of these cylinders of quartz are 2 ft. in diameter. Hartt spent some time in an examination of this vein for gold, but could detect none. The large size of the quartz veins of the vicinity may be inferred from the dimensions of the quartz boulders scattered over the surface, some of which weigh many tons. Hartt is not aware that any auriferous vein has been worked at or near Minas Novas, but at the Arraial da Chapada several were anciently more or less exploited. A rich vein, according to universal testimony, crosses the *praça* and it is well known that a miner followed it in secret, until he undermined his neighbour's house, when his secret was let out. There one hears the terms "vein" and "gravel" gold, and Hartt saw many beautiful specimens of crystallized gold in the hands of the inhabitants, some taken directly from quartz veins, others obtained from quartz boulders. There can be no doubt that rich auriferous lodes exist in the neighbourhood, which have never been explored, and which one day must be developed; for all the gold which so richly abounds in the drift, must have come from the underlying rocks.

The decomposed rock is immediately overlaid by a sheet of *cascalho* or quartz pebbles, whose thickness varies from a few inches to 8 or more ft. The pebbles are of all sizes, and are more or less rounded. Hartt observed in several localities that there were large boulders lying in this gravel, just above the rock. The *cascalho* is often so cemented by ferric oxide as to form a conglomerate, which requires to be broken up before it is washed for gold. Like the drift pebble sheet of the coast, it forms a concentric layer wrapped over the whole rock surface of the hills, and it is found lying on very high slopes and piled up in masses such as water never deposits.

It is in the *cascalho* that the greater part of the gold of Minas Novas and vicinity occurs. Over this gravel lies a mass of red drift-clay, varying very much in thickness, from a few inches to 50 ft. or more. This is, like the drift-clays of the coast, a homogeneous mass, through which are scattered from time to time angular and rounded quartz boulders of large size. Over large tracts between Minas Novas and the Arraial da Chapada, this sheet of clay is so thin that the *cascalho* bed lies on the surface, and the country is consequently stony and barren. The clay contains sometimes more or less gold. It is, however, to the *cascalho* sheets that the search for the precious metal has been principally confined. The gold occurs disseminated through the gravel in flattened grains, and in occasional nuggets of considerable size, which are always in a crushed and battered state. The process of extraction is similar to that described by Mawe, as employed at the mines of Jaraguá, in São Paulo. It consists in stripping off the clay sheet down to the gravel, which is broken up and washed on the spot in rude trenches, to separate the pebbles, when the auriferous mud and sand are washed in the *batea* or wooden washing-pan. A large number of the washings are situated on the tops of hills, or slopes at some height above the water of the stream; and in these cases, washing is performed through the aid of rain-water. In several localities, water is conducted to the washings from streams. Some of the old *regas* or ditches are still visible, running for miles around the hills. The supply of rain-water is of course sufficient only during the rainy season, so that washing operations had to be suspended for the rest of the year.

In the old washings, as in that above the cemetery at Minas Novas, or the Lavra da Santa Cruz, at the junction of the Rios Fanada and Bom Successo, the gravel lies in great piles. At the Arraial da Chapada, the same thing is seen; but there the whole tops of hills have been deprived of their clay coating, and washed over, so that to-day they are hoary with the quartz boulders that remain, the testimony of a departed industry. Hartt was informed that the custom with the miners was, as a general thing, to wash the gravel on the spot. It seems wonderful that when the washing was near a river or stream, the gravel was not sent down to this stream to be washed. To-day the washings, though owned by private individuals, who to some extent know their value, are unworked, the owners finding it more profitable to pursue agriculture, or wash for diamonds in the Jequitinhonha. The abundance of gold over this region may be seen from the nuggets in the possession of the people, and which have been picked up on the hill-sides or in rain-gullies. After rain, one sees in the ravines the footprints of those who regularly go in search of gold washed out by the surface waters; and in the streets of Minas Novas and Chapada, little dams are built across the small rain-gullies by the children, to collect water to wash the soil for gold, which they collect in quills, and larger dams are built by the elder members of the population for the same purpose. "No one who has been over the ground as I have (says Hartt), and has seen the irregular way in which the mining has been performed, and the immense area of drift which has yet been untouched—drift rich in gold, as the occasional recent washings testify, can doubt that the region is far from exhausted; it has only been forgotten." His friend, J. S. Mills, of New York, an excellent geologist, who discussed these observations with him, suggested that the gold probably occurs in bands in the drift, the direction of which might be worked out by a careful topographical survey. With modern mining methods and appliances, they would undoubtedly prove very remunerative. The system of washing by hose-pipes could be employed successfully in many localities.

Gold also occurs in the gravel and sands of the streams, these loose materials being derived in part from the drift, in part from the decomposed rock. Near the Arraial da Chapada is an outlier of the Tertiary, called the Serra do Macaco, which forms a very picturesque flat-topped mountain, with escarped sides, in which the horizontal layers of red and white clays are beautifully exhibited. Hartt queries whether the lower beds of this series may not be found to be auriferous in some places. Finally, the sands of the Arassuahy, above the Rio Setubal, or thereabouts, are rich in gold.

Bahia.—Some of the hills in the Serra de Itaráca must be 3000 ft. high or more ; and Prince Neu-Wied says that gold is found here. The mountains in the vicinity of the fazenda of Joazeiro are of granite and gneiss-granite. Gold occurs in veins in the rock, and also in the sands and gravels of the Brumado and other streams, where it is found in grains and nuggets. Spix and Martius speak of one nugget having been found weighing 8 lb. Two leagues north of the villa are other gold-deposits.

Ceará.—Villa das Lavras da Mangabeira is situated close to the Rio Jaguaribe, and takes its name from a number of small gold-washings (*lavras*) which, from time to time, for many years past, have been wrought in its neighbourhood. Nothing, however, was done to any extent till about 2 years ago, when 2 English miners were sent for by a company in the city of Ceará, the capital of the province. They continued their labours till about 2 months before Hartt passed through the place, having been recalled by their employers. He could not learn what amount of gold they had obtained, but the persons of whom he made inquiries remarked, with apparently much truth, that they did not believe it was sufficient to repay the expense, or the work would not have been abandoned. The gold is here found in small particles, in a dark-coloured diluvial soil, at a considerable depth. At Granja, Baturité, Crato, Termo de Milagres, Ipú, Rio Salgoda, from Missão-Velha to Lavras: in all these places, gold occurs in grains or powder in sands, gravels, or clays ; its source is not known.

Maranhão.—Gold occurs in the province of Maranhão, and has been worked by a mining company ; but Hartt was unable to obtain facts bearing upon the nature of the deposits, or their yield. The two principal mines are those of Turí and Maracassumé.

Goyaz.—Gold is found in many localities in the province of Goyaz. The country in the vicinity of the capital is largely auriferous. Castelnau speaks of the occurrence of the precious metal at the following localities :—Rio Vermelho, Rio Bagagem, Serra Dourado, Districto de Ouro Fino, Morro do Calisto, Districto da Anta, Thesouras, Rio Claro, Julgado de

Crixas, Natividade, Trahiras, &c. In the valley of the Paraguay, near Cuiabá and Diamantino, diamonds and gold occur in abundance.

Provinces South of Rio.—At Itú, a short distance from São Paulo, the Rio Tieté is represented by Major James as cutting through horizontal deposits of red sandstone and conglomerate; and this is the material which is used to pave the streets of the capital: as Fletcher and Mawe have remarked, the rock contains gold. Mawe, speaking of the streets of São Paulo, says the pavement is an "alluvial formation, containing gold, many particles of which are found in the chinks and hollows, after heavy rains, and at such seasons are sought for by the poorer sort of people."

Westward of São Paulo, are some high hills, the most conspicuous being Jaraguá, in whose vicinity gold-mines were anciently worked.

The occurrence of gold in the gneiss regions of the Serra do Mar, at São Paulo and Cantagallo, and in the same Eozoic belt on the Mucury, as reported by the engineer Schieber, is interesting, as these rocks are rarely over rich in the precious metal, and the whole gneiss belt of Brazil is remarkably barren of metalliferous deposits of all kinds.

Gold is said to occur in the Villa de Guarapuava, to the west of the River Tibaji, and elsewhere in the province. Pompéo says the gold-mines of São Paulo produced up to the beginning of the present century 4650 *arrobas* (150,520½ lb.) of gold.

The Gold-mines generally.—In this section, Hartt endeavours to present such facts as will enable the reader to obtain a fair idea of the mode of occurrence of gold in Brazil, and of the character of the mines. A great amount has been written on the gold-fields of Brazil, but it is for the most part lacking in scientific accuracy, and much of it has rather tended to obscure than throw light upon their real structure.

The Auriferous rocks.—The Eozoic gneiss of the coast-belt furnishes gold at numerous localities along its whole extent. Hartt thinks that the auriferous deposits occur in the upper part of the gneiss series. Gold is found in the gneisses of the Itacama Mountains. The mines of Jaraguá in São Paulo, of Cantagallo in Rio de Janeiro, and of one of the tributaries of the Itapémerim, are among the most important in this region. Gold also occurs in the gneiss of the Mucury basin, and in the north, as at Piancó. Over this whole region, the metal is found rather sparingly, and appears to be derived from the quartz veins traversing the gneiss; but probably the only instance where gold has been extracted from a quartz vein in the gneiss-belt is the mines on the Rio Bruscus in Parahyba. With this exception, mining has been confined entirely to the washing of the *cascalho* underlying the drift-clays, and of the gravels and sands of the rivers. These washings have all been abandoned. Between the coast gneiss-belt and the sea, are no auriferous deposits;

but in very numerous localities in the interior of the country, the newer metamorphic rocks are rich in gold.

In the clay-slates, the quartz veins sometimes show free gold, with very little pyrites associated. The auriferous quartz varies much in character. Sometimes it is compact and milky, at others, as at the Cata Branca mines, it is very granular and sugary. A specimen of vein-quartz with gold, from the mine of São Vicente, in Minas Geraes, is composed for the most part of clear, colourless quartz, in rather coarse granules, giving to the rock the appearance of a pure quartz sandstone, or of white lump-sugar (known in Brazil by the name of *cacó*); but in the same specimen, the quartz passes into a more compact bluish rock.

In the quartz veins, as is elsewhere the case, the rock is not all auriferous, but the gold runs in streaks. The São Vicente specimen above described shows well-marked streaks, rich in free gold, which appear to have run parallel with the side of the lode.

Where the vein-rock is rich in sulphides, the gold is, as a rule, not visible, but intimately mixed with the rock. This is the case at Morro Velho. The sulphides consist of magnetic iron-pyrites, which is the most abundant, and yields a little gold; common iron-pyrites is less abundant, and gives more gold; and mispickel or arsenical iron-pyrites, which is the principal gold-bearer.

Of the ferruginous deposits, none is more interesting than the so-called *jacutinga* formation. Heusser and Claraz (Ann. des Mines, xvii. 290), describe it thus:—

> "L'itabirite est simplement une variété de fer-oligiste schisteux, qui est accompagnée de quartz et de mica. Elle présente quelquefois des couches puissantes et très-étendues, qui peuvent être exploitées comme minerai de fer. Quand elle est pulvérulente, on la désigne sous le nom de *jacotinga*."

It is, in fact, a pulverulent variety of itabirite, a name bestowed by Von Eschwege, thus:—

> "Itabirit,—Eisenglimmer, Eisenglanz, meist dichter, auch blättriger, hin-und-wieder magnetischer Eisenstein und wenig Quarz erscheinen, entweder als festes, dichtes Gestein, oder haben ein körnigschiefriges Gefüge."

This rock is composed of micaceous specular iron ore, compact specular iron, rarely laminated, a little oxide of iron and quartz disseminated. It is the rock of which the Peak of Itabira and the Serra da Piedade are formed.

Burton describes *jacutinga* as of iron-black colour, with metallic lustre, sparkling in the sun with silvery mica; the large pieces often appear dark reddish-brown, but crumble to a powder almost black. The constituents are micaceous iron-schists, and friable quartz mixed with specular iron, oxide of manganese, and fragments of talc. Much of it is foliated. It shows great differences of consistency, some being as hard and compact as hæmatite, and requiring to be stamped like quartz. In parts it feels soapy, and is not harder than fullers'-earth; it is easily wetted and pulverized, but hard to dry.

Gardner describes *jacutinga* as a soft, friable, greenish-coloured, micaceous iron-schist. Its gold is free. Castelnau says, that at Gongo Soco, the gold is always confined to a little vein, which winds about in the rock. This is never more than 5 to 7 millimetres (0·195 to 0·273 in.) in width, and sometimes it is as thin as a hair.

In the gold-region, is found an auriferous superficial deposit of broken fragments of ferruginous rocks, cemented together, and called *tapanhoacanga* or *canga*. This formation has been minutely described by Von Eschwege, substantially as follows:—

The rock is composed of sharp-cornered, angular (rarely slightly rounded) fragments of micaceous iron (*eisenglimmer*), specular iron, and magnetic oxide of iron, held together by a red, yellow, or brown, ochreous cement, the fragments being several lines to 8 in. in diameter. It is often very auriferous, and sometimes contains scales of talc and chlorite, and stray fragments of *itacolumite*. The cement becomes in places so abundant that the imbedded pieces are not visible; this then forms distinct deposits of red ironstone in thin layers, containing ordinarily many little flakes of mica. The rock is not only found in the valleys and on the slopes of the mountains, but it covers their most elevated ridges and flanks like a sort of mantle, ½ to 1½ *toise* in thickness [a *toise* equals 6·395 ft.]; it is in general superimposed upon the ferruginous schist and clay-slate. The most important foreign mineral deposits found in it are brown hæmatite and wavellite, which occur in considerable masses near Villa Rica. The Serra do Tapanhoacanga, near Congonhas do Campo, province of Minas, whose summit rises to a height of 4800 ft., is completely covered with it over an area of several miles; all the flank of the mountain where Villa Rica is situated is encrusted with it; the surface is overturned by the mining works. The Campo de Saramenha, opposite, is as if paved with it. It is abundant along the route from Villa Rica to Serro do Frio; it is probably also found in the province of Goyaz.

It is difficult to explain (says Von Eschwege), the origin of this conglomerate. The angular fragments, the irregularity with which they are piled up one on the other, the manner in which this rock covers, like a coat or glazing, the top and flanks of the mountains, tend to make one believe that it is not the result of the rapid degradation of the ferruginous mountains, which formed only the most elevated points in the country, and of which the peak of Itabira, the Serra da Piedade, and others are the remains; but that it is due to the extremely prompt drying up of the liquid which sojourned formerly on the mountains, and has brought there the fragments which to-day cover them. These could not follow the liquid to the bottom of the valleys, and were arrested like solidified lavas on the midst of the slopes. The disorder with which they are piled up proves sufficiently that the deposit was not gradually made. Castelnau says that the *canga* is certainly of plutonic origin. Glacial drift seems to have been unknown to these geologists.

São João d'El Rei mine.—At São João d'El Rei and São José, situated a few miles west of Barbacena, on the Rio das Mortes, are auriferous deposits formerly worked for many years with great profit. In 1830, an English company leased these mines; but in 1834, they were found unprofitable and were abandoned. Burton says the gold was principally obtained from a lode, which however, he does not describe. The *jacutinga* formation is said to occur here.

Ouro Preto.—The country over a very large area in the vicinity of Ouro Preto is very auriferous, and here are situated the richest gold-mines of the empire. The gold occurs primarily in quartz veins traversing metamorphic rocks, such as clay-slate, mica-slate, iron-schists, &c.; also disseminated through the rock in some places; and secondarily it is found widely distributed in drift and alluvial sands and gravels.

Morro Velho.—The celebrated Morro Velho mine is situated on the western side of the valley of the Rio das Velhas, not far from Sabará. It was long worked by native miners, but on the failure of the mines at São João d'El Rei, it was purchased by the "St. John del Rey," company, and has been worked with remarkable success ever since. The gold is extracted from a lode of quartz enclosed in clay-slate.

Gongo Soco.—The gold-mines of Gongo Soco lie about 20 miles east of Morro Velho, on the opposite side of the valley of the Rio das Velhas. They were very productive, and became famous; Weddell says that the old miners once took out 100 lb. in 3 hours; but through bad management, the company that worked them failed. The income of the company during the 30 or more years of its existence was, according to Moraes, 1,338,416*l.*, of which, 375,163*l.* was profit.

Gardner says, on the authority of Helmreichen, that at the Gongo Soco mine there is the following succession of rocks:—a bed of *itacolumite*, underneath which is a bed of auriferous *jacutinga* 50 fathoms thick [while Castelnau says that the *jacutinga* here is ordinarily only 16 centimetres (6¼ in.) in thickness], then a thick layer of ferruginous *itacolumite*, with a dip of 45°, lying on clay-slate, containing masses of ironstone. Underlying the slates is granite. Castelnau says that these beds dip S. The gold occurs free in the *jacutinga*, and is separated by washing.

Weddell describes the Gongo Soco *jacutinga* as black and friable as coal; it was said to be very soft, so as to admit of being worked with a pick, and blasting was unnecessary. When the gold was not visible, the ore was stamped and washed without using mercury. When the precious metal was visible, it was treated first in a mortar, and then washed in a *batea* or wooden washing-bowl. The Gongo Soco gold is deep-yellow in colour, and is said to contain palladium. The gold of Brazil is always alloyed with silver, and occasionally with platina ; sometimes it contains a considerable percentage of iron, when it is very dark in colour. Iridium and irid-osmium occur in the gold-washings of Minas. Burton has seen specimens "of a bright brassy tint, and sometimes dingy red, like worked unpolished copper."

Rossa Grande.—The Rossa Grande Gold-mining Company owns a tract of land 21 sq. miles in area, not far from the mines of Morro Velho. The gold occurs in a mixture of quartz, sometimes associated with iron-ore, at others with arsenical pyrites, or ferric oxide. Some of these ores are said to be very rich, producing even as much as 50 *oitavas* (5 oz. 15 dwt. 7 gr.) to the ton. Besides the vein-rock, gold occurs in *jacutinga* and in alluvial washings. Burton visited the mine, and reported it as looking very much like a failure.

Morro de Santa Anna.—The Morro de Santa Anna, where the "Dom Pedro North del Rey" Company was established, is a mountain about 4000 ft. above the sea and some 2000 ft. above the neighbouring valley. Near Santa Anna is another mine, called Maquiné, worked by the company owning the Morro Santa Anna, which has been abandoned. "Out of all the gold-mines of Brazil (says Hartt) only two have paid,—Morro Velho and Maquiné. The rest have failed, some of them after a more or less prosperous career, and notoriously in most cases from bad management, and an imprudent outlay of funds."

Cata Branca.—In 1843, D'Osery, geologist of the expedition of Count Castelnau, visited and examined the Cata Branca mine. He reported the rocks to consist of *itacolumite* and clay-slates alternating, and in strata almost perpendicular. He describes the auriferous vein as running nearly N.–S., and traversed by fissures or faults in which the gold occurred. It was also found in the fissures for a distance of 2 or 3 palms on each side of the line of the faults, together with bismuth. Sometimes gold was found where the vein-quartz came into contact with the enclosing rock ; the interior of the vein was very barren. D'Osery thought that originally the vein was composed of pure quartz, which was afterwards disturbed, and the gold and bismuth introduced by sublimation. The mine proved a failure, because of bad working and want of economy.

Exhaustion of the Mines.—The generally received impression that the gold-mines of Brazil are exhausted is, in Hartt's opinion, a very great mistake. There are still surface deposits of wide extent which, with modern appliances, could be successfully worked. The underground wealth of the country is almost untouched. In this belief he is supported by Burton; and Liais, in treating of the head of the basin of the São Francisco, says:—

> "Quant aux filons pyriteux qui abondent dans les régions montagneuses circonscrivant le bassin du São Francisco, et où ses divers affluents prennent leur source, ils ont été à peine attaqués. C'est là cependant que réside la grande richesse aurifère de la province de Minas Geraes, car c'est de la surface décomposée de ces filons pyriteux qu'était provenu l'or qui fut jadis retiré des dépôts meubles."

Glacial Drift.—In South America, from Tierra del Fuego northward to at least 41° S., glacial phenomena have been observed and reported by Darwin and others; and these phenomena appear identical with those so well studied in the northern hemisphere. Drift occurs in the Falkland Islands, Australia, and New Zealand. The antarctic continent is buried in ice and snow. No doubt can exist that a drift period prevailed over the southern part of the southern hemisphere. D'Archiac called attention to the fact that no mention of either striæ, furrows, or polished surfaces had been made by those who studied the drift of South America; and he suggested that it might be perhaps owing to want of attention on the part of travellers.

When Professor Agassiz claimed, in 1865, to have found glacial drift in the vicinity of Rio, scientific men were astonished, and doubted the correctness of his deductions; and when from under the equator he reported the discovery of glacial moraines, the statement seemed past belief. In connection with a careful description of the Brazilian coast, Hartt noted with much detail the occurrence of certain surface deposits northward to Pernambuco at least, which deposits he claims to be glacial drift. The glacial origin of the *tapanhoacanga* or *canga* has been already (p. 222) discussed.

To this scientific account of the Brazilian auriferous deposits, may be added the testimony of various travellers, foremost among whom is Mawe He first alludes to the old gold-mines of Jaraguá, the first discovered in Brazil, and distant about 24 miles from the city of St. Paul. They were famed for the immense treasures they produced nearly two centuries ago, when at the ports of Santos and St. Vincent, whence the gold was shipped for Europe, this district was regarded as the Peru of Brazil. The face of the country is uneven and rather mountainous. The rock, where it is exposed, appears to be primitive granite, inclining to gneiss, with a portion of hornblende, and frequently mica. The soil is red, and remarkably ferruginous, in many places apparently of great depth. The gold lies, for the most part, in a stratum of rounded pebbles and gravel, called *cascalho*, immediately incumbent on the solid rock. In the valleys, where there is water, occur frequent excavations, made by the gold-washers, to a considerable extent, some of them 50 or 100 ft. wide, and 18 or 20 ft. deep. On many of the hills, where water can be collected for washing, particles of gold are found little deeper than the roots of the grass.

The mode of working these mines, more fitly to be denominated washings, is simple, and may be easily explained.

Suppose a loose gravel-like stratum of rounded quartzose pebbles and adventitious matter, incumbent on granite, and covered by earthy matter of variable thickness. Where water of sufficiently high level can be commanded, the ground is cut in steps, each 20 or 30 ft. across, 2 or 3 ft. broad, and about 1 ft. deep. Near the bottom, a trench is cut to the depth of 2 or 3 ft. On each step stand 6 or 8 negroes, who, as the water flows gently from above, keep the earth continually in motion with shovels, until the whole is reduced to liquid mud, and washed below. The particles of gold contained in this earth descend to the trench, where, by reason of their specific gravity, they quickly precipitate. Workmen are continually employed at the trench to remove the stones, and clear away the surface, which operation is much assisted by the current of water which falls into it. After 5 days' washing, the precipitation in the trench is carried to some convenient stream, to undergo a second clearance. For this purpose, wooden bowls are provided, of a funnel shape, about 2 ft. wide at the mouth, and 5 or 6 in. deep, called *gamellas*. Each workman, standing in the stream, takes into his bowl 5 or 6 lb. weight of the sediment, which generally consists of heavy matter, such as oxide of iron, pyrites, ferruginous quartz, &c., of a dark carbonaceous hue. They admit certain quantities of water into the bowls, which they move about so dexterously that the precious metal, separating from the inferior and lighter substances, settles to the bottom and sides of the vessel. They then rinse their bowls in a larger vessel of clear water, leaving the gold in it; and begin again. The washing of each bowlful occupies from 5 to 8 or 9 minutes; the gold produced is extremely variable in quantity, and in the size of its particles, some of which are so minute that they float, while others are found as large as peas, and not unfrequently much larger. This operation is superintended by overseers, as the result is of considerable importance. When the whole is finished, the gold is borne home to be dried, and at a convenient time is taken to the permutation office, where it is weighed, and a fifth is reserved as royalty. The remainder is smelted by fusion with muriate of mercury, cast into ingots, assayed, and stamped according to intrinsic value, a certificate of which is given; after a copy has been duly entered at the mint office, the ingots circulate as specie.

The gold-washing at Santa Rita is distant from Cantagallo about 5 leagues in a north-east direction. The washing is in a deep ravine. The stratum of *cascalho*, which lies under a bed of soil 4 or 5 ft. deep, is very thin and uneven, being nowhere more than 2 ft. thick, and in many parts not more than 7 or 8 in. The incumbent soil is removed at great labour and expense, being dug out and carried away in bowls; and the *cascalho* is conveyed with great care to a convenient place for water, where it is washed by the most expert among the miners, in a way similar to that practised at the mines of Jaraguá.

When the *cascalho* is below the bed of the river, means are required for drawing the water from the pits. The hydraulic machines employed for this purpose are constructed as follows:—A trough or spout, made of 4 stout planks, forming a cavity, say 6 in. square, is placed in an inclined position, with its lower end in the pit, where a roller is properly secured to a pile driven into the ground; an iron chain, with peculiar links, on every one of which is fixed a piece of wood, nearly answering the interior dimensions of the spout, is passed through it, then under the roller, and over the outside, up to the axis of a water-wheel, which, being put in motion, causes the discharge of a column of water equal to the cavity. These machines are calculated to raise a great deal of water, but they are liable to be thrown out of repair.

Caldcleugh (1819–21), speaking of the Paraibuna, says that it flows down from the back of the Serra da Mantequeira, under the name of the Rio Preto, which is in fact a mere translation of the Indian word Paraibuna. It is here about 50 yd. across, and flows with a turbid but rapid current, half a degree farther to the east, where it joins the Paraiba. Its sand is eminently auriferous, and in front of the registro many canoes were at work. By means of a windlass and an iron scoop, the gold-washers dredge up into the canoe a portion of the bed of the river, and when they have procured as much as they can carry, they move to their washing-place, which is a kind of platform projecting over the river; the *cascalho* or gravel and sand is then shovelled into a large trough, and upon it a neighbouring stream is conducted by means of large bamboos. The canoes are very large, and formed out of a single tree. There were usually three blacks in the canoe, and two on the platform, who received a *patach* or 320 *reis* (8·65*d.*) per diem each, which, for 5, amounted to 1600 *reis* (3*s.* 9¼*d.*); and as the daily gain was generally equal to 2200 *reis*, there was a balance of 600 *reis* for the owners of the boat. One of the patrãos informed Caldcleugh that he frequently collected with three boats 5 or 6 *oitavas* (11¼ to 14 dwt.) of gold in the course of the day. The gold he showed was fine-grained and of good colour. The gravel brought up with it consisted chiefly of quartz of a brilliant whiteness, rounded cornelians of a yellowish-red tint, some agates, and aquamarines of a muddy bad colour. Caldcleugh obtained from the mass of refuse several specimens of this description, and a few water-worn wine-yellow topazes. On the bank of the river, he observed many large masses of ferruginous quartz, destined, perhaps, when the process of decomposition is completed, to add a small stock of gold to the sands of the stream, whence large quantities have been already obtained.

The Rio Maranhão, with its red muddy stream, pursues a winding course, and has produced considerable quantities of gold.

At the gold-washing about a league distant from Congonhas, 5 leagues from Queluz, the gold exists in a very friable quartz rock, traversing in veins a greenstone slate. These veins are porous, and in their cavities the gold, of about 22 carats fine, is disseminated, and distinctly visible to the naked eye. Grains of a black shining substance, which probably are merely oxide of iron, accompany the gold, which does not put on any geometrical figure, but seems composed of sharp angular particles. Large masses of greenstone slate, in a state of decomposition, and appearing like fullers' earth, lie on each side of the veins. The quartz is placed under stampers, and a stream of water carries off the coarser sand in one direction, while in another a number of hides, placed in the contrary direction to the lay of the hair, secure the lighter particles of metal.

The metalliferous veins 1 league from Passagem, 6 in. to 1 yd. in width, consist of quartz, containing schorl, arsenical and iron-pyrites, gold, and arseniate of cobalt. The overseer showed Caldcleugh some plants whose juice is squeezed into the bowls containing gold, to carry down the lighter particles. There were several plants in common use for this purpose, but the one generally preferred, from its containing more juice, was called *itambamba*; it appeared to be a *Solanum*. The leaves had a bitter taste and gummy feel.

The Rio das Velhas, a very considerable stream, has produced and yet produces large quantities of gold.

The gold-works near the village of Santa Rita are situated in an immense *quebrada* or ravine, which has been worked almost through the heart of a mountain of chloritic slate, intersected by quartz veins, in which the gold exists in combination with arsenical and iron-pyrites. The chloritic slate, which is highly inclined, also contains gold in the proximity of the veins, and, as well as the quartz veins, is carried to the stamping-mill.

According to E. Williamson, who accompanied an expedition to examine the new gold-fields of Caxoeira of Piancó, in the south-western extremity of the province of Parahyba, a section along the valley of the river Bruscus shows the rocks at the Minas das Caxoeira, and the position of the gold bearing veins, to be as follows. At the southern extremity are two bands of syenitic gneiss; underlying these is a series of schistose gneiss, and a narrow band of syenite. Succeeding these are the gold-bearing series, which almost wholly consist of fine-grained micaceous gneiss, passing imperceptibly into mica-schists. The auriferous veins which traverse the rocks are very numerous. They appear as irregular lenticular masses, running parallel to the strike, often dipping between, but rarely cutting through, the beds. The matrix of the lodes is a coarse white semi-opaque quartz, containing small quantities of the arsenides and sulphides of iron, and sulphides of copper, lead, and zinc; most of the galenas contain antimony. The variety of minerals resulting from the decomposition of these ores is very great: carbonate of zinc, carbonate and chloro-phosphate of lead, phosphate, arseniate, and carbonate of copper, oxides of antimony, and native sulphur are common in some of the lodes; sulphate of copper, sulphate and chromate of lead are more rare; native gold is sparingly scattered throughout nearly all the lodes, and in the Boa Esperança veins grains of platinum are found. The run of rocks in the valley of the Bruscus are very auriferous, and quartz veins are abundant; and though the rocks are greatly contorted no trace of a true fault can be found anywhere in the whole district. To this want of true fractures, Williamson ascribes the poorness of the quartz veins: there being nothing favourable to the concentration of the ores, the gold has been equally distributed throughout all the veins. The whole series agree in every respect with the characteristic features of the Canadian Laurentian rocks, as given by Sir W. E. Logan.

Mulhall (1873) says that gold abounds in the Cuñapiru district (in the Rio Grande do Sul province), near Banda Oriental. He adds that Correa Camara gives a list of minerals found at various places, which may be summarized thus:—Gold at Piratiny, Encrusilhada, and San Gabriel.

Scully (1866) makes numerous references to gold, which may be epitomized as follows. The province of Mato Grosso was at one time very productive in gold. The mineral productions of the province of Goyaz include gold; but the mines, which up to the beginning of this century had yielded nearly 150 tons of gold, seem almost exhausted. There are various mines of gold in the province of Maranhão. The province of São Pedro do Sul is rich with gold. The mineral wealth of Minas Geraes is exceedingly great. Of gold it has already produced about 550 tons. Little has been done in the examination of the mineral resources of the province of Para, yet it has been ascertained that gold exists. Gold is also found in the province of Ceará. The mineral wealth of São Paulo is great, the gold-mines alone having produced, up to the end of the last century, nearly 70 tons of that metal. The mineral wealth of the province of Alagoas does not seem to be great, though gold has been found. The province of Bahia abounds in mineral riches. The gold-mines of Chapada, Gentio, and Sincora, while worked, were very lucrative.

The gold-mines in the *jacutinga* formation have recently (1879) been described by Dietzsch (Min. Jl., xlix. 239), whose remarks may thus be summarized. The mineral denominated *jacutinga* by the Brazilian miner is a pure iron-ore, and forms a fine-grained rock of distinctly foliated structure. In some localities, it alternates with thin layers of white quartz, giving to the whole formation a ribbon-like striped appearance, of a whitish and iron-grey colour. Pure specimens of the mineral contain 97 per cent. of sesquioxide of iron, 0·15 to 0·20 per cent. of manganese, 0·30 per cent. of lime, and 1 to 2 per cent. of silica. Strata of *jacutinga* of stupendous magnitude traverse the mining district of Minas in four distinct formations, which have a width of ½ to upwards of 1 mile, and a longitudinal extent of 30 to 40 miles; they are, in fact, mountains of iron-ore. The direction of these strata is generally N.N.E. S.S.W., with an inclination towards E. The *jacutinga* is frequently superincumbent to the *itacolumite*, a rock likewise peculiar to the country, and which is chiefly a fine-grained quartz, united by thin laminæ of chlorite and talc.

It must not be supposed that all the *jacutinga* is auriferous. There are only some of the beds which contain the precious metal in a limited longitudinal extent, and these sections are called by the miners lodes. While the whole bulk of these lodes is in some degree auriferous, they contain again a number of veins, pre-eminently rich, and generally well defined, dipping invariably N.E. These veins are sometimes also termed lines of gold, and vary in size from 1 to several inches and even feet in thickness; they approach in one locality of the lode the head-wall, in another the foot-wall, and are considered particularly rich when accompanied by mineral having the appearance of a very friable grey sandstone. Bunches are very rich accumulations of gold, and it has been found that those encountered in the deeper workings of the Maquiné mine have always been richer than those met with in the higher parts of the lode; it is considered a very good sign when the iron accompanying the gold in the bunches assumes a hydrated frosty appearance.

It has been the general practice in *jacutinga*-mining to pursue and excavate the veins of gold as soon as discovered, either by rising or sinking diagonal excavations from different levels; and the product of such workings is termed "vein-stuff" or "box-work," because it is transported to the reduction-works in locked boxes. The ground between the lines or veins, and that above and below them, though generally auriferous, is for the time left standing, to be excavated by the general stoping afterwards. There are, therefore, generally two distinct stoping operations—a system which in general mining would be considered unfair working, but which in this kind of mines has certainly its advantages; it facilitates a proper separation of the concentrated rich vein-stuff from the poorer minerals, a necessity commanded both by the requirements of the extraction process, and on account of the ease with which gold may be extracted by the workpeople if left in the general stopes.

The village of São Gonzalo, which is three leagues N.N.E. from Santa Barbara, is said by Spix and Martius to have possessed, above 30 years ago, very considerable gold-washings. From São Gonzalo to Villa da Campanha (Minas Geraes), they met everywhere with indications of the gold-washing; the trenches, in particular, by which the water required is led from the highest parts of the country, are often of surprising extent, and run for leagues along the declivities of the mountains. The mountains consist of granite, which not unfrequently passes into gneiss, and the felspar of which is almost entirely decomposed into kaolin. Here and there veins of quartz traverse the rock in manifold directions and these always abound in disseminated gold. According to them, the gold-washing in the Ribeirão de Ouro Preto, is thus performed. The gold-washers (*faiscadores*) are dressed in a leather jacket, and have a round bowl cut out of the wood of the fig-tree (*gamelleira*), from 1½ to 2 ft. in diameter, and 1 ft. deep (*gamella*, *panella*, *batea*), and a leather bag fixed before them. They generally select those places in which the river is not rapid, where it makes a bend, and has deep holes. They first remove the large stones, and upper layers of sand, with their feet or their *gamella*, and then take up a bowlful of the deeper and older gravel of the river (*cascalho virgim*). They continue to stake, wash, and strike off the stones and sand at the top, till the heavy gold-dust appears, pure, at the bottom of the vessel, on which a little water is thrown in with the hand, and the gold at length put into the leather bag. This mode of gold-washing is here called *mergulhar* ("diving"). They sometimes wash the *cascalho* upon a platform (*canoa*) erected on the spot.

Writing in 1880, Max Beschoren (Proc. R. Geogr. Soc. ii. 702–3) says of the South Brazilian plateau comprised between the rivers Ijuhy Guassu and Passo Fundo, southern tributaries of the Uruguay river, that the country consists partly of highland, and partly of rich slopes gradually descending to the bed of the Uruguay river; metals are known to exist here, the old Jesuit missions having worked gold, silver, and copper mines, and a resident of Palmeira, a few years since, having brought back from the region referred to, unmistakable evidence of mineral wealth, in the shape of a bag of gold-dust.

A vast amount of commercial and general information concerning the gold-mining industry of Brazil, will be found in Captain Burton's two volumes on 'The Highlands of the Brazil,' an indispensable companion for all engaged in developing the auriferous resources of the country. And the very ardent student may digest Henwood's exhaustive "Observations on Metalliferous Deposits," occupying over 700 pages in the

'Transactions of the Royal Geographical Society of Cornwall,' and to which further reference will be made in the next chapter.

CHILI.—Dr. Soetbeer gives the following table of the gold-production of Chili in the years 1545 to 1875:—

Period.	No. of Years.	Total.	Annual Average.	
		lb.	lb.	£
1545–1560	16	70,400	4,400	279,000
1561–1580	20	17,600	880	55,800
1581–1600	20	17,600	880	55,800
1601–1620	20	15,400	770	48,825
1621–1640	20	15,400	770	48,825
1641–1660	20	15,400	770	48,825
1661–1680	20	15,400	770	48,825
1681–1700	20	15,400	770	48,825
1701–1720	20	17,600	880	55,800
1721–1740	20	17,600	880	55,800
1741–1760	20	22,000	1,100	69,750
1761–1780	20	44,000	2,200	139,500
1781–1800	20	88,000	4,400	279,000
1801–1810	10	68,420	6,842	433,845
1811–1820	10	44,000	4,400	279,000
1821–1830	10	26,400	2,640	167,400
1831–1840	10	26,400	2,640	167,400
1841–1850	10	22,000	2,200	139,500
1851–1855	5	4,400	880	55,800
1856–1860	5	3,300	660	41,850
1861–1865	5	4,400	880	55,800
1866–1870	5	4,400	880	55,800
1871–1875	5	4,400	880	55,800
		Total.		
1545–1850	306	559,020	35,446,950*l.*	
1851–1875	25	20,900	1,325,250*l.*	
1545–1875	331	579,920	36,772,200*l.*	

The exports from Caldera in 1875–79 are thus officially stated:—

	Bar Gold.	Silver, Gold, and Copper Regulus.	Silver and Gold ores.
	lb.	lb.	lb.
1875	39	101,178	177,672
1876	22	18,114	206,448
1877	6½	15,457	119,658
1878	26	..	214,368
1879	88	636,704	..

In his observations on a 'Voyage into the South Sea in the year 1593,' Sir Richard Hawkins (Hakluyt Soc., 1847, pp. 157–8) relates of the Indians in Chili, that they gather gold "in two manners: the one is by washing the earth in great trayes of wood in many waters," the other, "by force of art to draw it out of the mynes."

One of the earliest writers on Chili, Peter Schmidtmeyer (1824), says that from Santiago to Copiapo are valleys which, although now only watered by very small rivers, show traces of having been once filled up by them to a height of 30 or 50 ft.; each bank is lined with a high, extensive mass of rounded stones mixed with earth, entirely dissimilar from the ground on each side of the valley, and two or three different banks are seen contracting as they lower, and shelving down with a regularity which seems to indicate that the water, after flowing a considerable time with an even stream, must have suddenly fallen much at different periods. It is in them, and often at a height of 20 or 30 ft. from the present bed of the rivers, that search is made for gold. To do so in the lowest channels, and by the sides of the streams now flowing, will not reward the labour, unless it be in some mountainous spots known to contain gold. He further alludes to the "gold mounts near Guasco," and to the gold obtained near Talca; and summarizes by saying that the "mines and washings for gold extend over most parts of Chili below the Andes, but the principal spots are near Copiapo, Guasco, Coquimbo, Ligua, Petorca, Tiltil, Caren, and Talca."

Caldcleugh (1825) remarks that far the largest proportion of the gold found in Chili is procured by means of washing the beds of rivers. It is of a very pure quality; he met with it in no instance crystallized, but in large flattened grains of a peculiarly bright colour. Not unfrequently beds of gold several inches thick are fallen in with; some of these beds have produced extraordinary quantities of metal. The only gold-mine he visited, which properly deserves the name of mine, was on the road to Valparaiso; it existed in a gangue of iron-pyrites, but was neither rich nor extensively worked. The auriferous iron-pyrites of Chili occurs isolated and finely crystallized. At Coquimbo, gold is found in a matrix of carbonate of copper.

Head mentions the gold-mines of El Bronce de Petorca, province of Aconcagua, and Caren, near Santiago.

According to the great naturalist, Darwin (1846), the strata surrounding the intrusive hillocks at the mines of Los Hornos, are intersected by many veins of copper-pyrites, associated with much micaceous iron-ore, and by some gold. At Yaquil, he observed that the principal auriferous veins ran nearly parallel to the grain or imperfect cleavage of the surrounding granitic rocks. With respect to the distribution of the different metals, copper, gold, and iron are generally associated together, and are most frequently found (but with many exceptions) in the rocks of the lower series, between the Cordillera and the Pacific, namely, in granite, syenite, altered felspathic clay-slate, gneiss, and (near Guasco) mica-schist. Gold occurs in its native form. It is believed that, in many cases, the upper part of the vein is the most productive; this fact Darwin considers to be probably connected with the abundance of the metal in the stratified detritus of Chili, which must have been chiefly derived from the degradation of the upper portions of the rocks. These superficial beds of well-rounded gravel and sand, containing gold, appeared to him to have been formed under the sea close to the beach, during the slow elevation of the land. Schmidtmeyer remarks (*v. ante*) that in Chili gold is sought for in shelving banks at the height of some feet on the sides of the streams, and not in their beds, as would have been the case had the metal been deposited by common alluvial action. Gold is often found in iron-pyrites; at two gold-mines at Yaquil (near Nancagua), Darwin was informed by the proprietor that in one the gold was always associated with copper-pyrites, and in the other with iron-pyrites; in this latter case, it is said that if the vein ceases to contain iron-pyrites, it is yet worth while to continue the search, but if the iron-pyrites, when it reappears, is not auriferous, it is better at once to give up working the vein. Although copper and gold are most frequently found in the lower granitic and metamorphic schistose series, yet these metals occur both in the porphyritic conglomerate formation (as on the flanks of the Bell of Quillota and at Jajuel), and in the superincumbent strata. At Jajuel, Darwin was informed that the copper-ore, with some gold, is found only in the greenstones and altered felspathic clay-slates, which alternate with the purple porphyritic conglomerate. Several gold-veins and some of copper-ore are worked in several parts of the Uspallata range, both in the metamorphosed strata, and in the intrusive andesitic rocks of that range. At Los Hornos (N.E. of Illapel) likewise, there are numerous veins of copper-pyrites and of gold, both in the strata of the gypseous formation, and in the injected hills of andesite and various porphyries. At the Durazno mine (Yaquil), the gold is associated with copper-pyrites.

Gilliss, who accompanied the U.S. Naval Astronomical Expedition to the Southern Hemisphere during the years 1849–52, remarks that the auriferous deposits near Illapel, Petorca, and Andacollo, have been the most productive of the Aconcagua gold-washings, those of La Ligua, on a hill just to the northward of Quillota, and of Catemo, 12 leagues nearer to the source of the river, were among the most noted. The gold-mines of Chivato and Chuchunco, on the summit of Cerro Chivato, have occasionally yielded rich ores; they have been worked for nearly 100 years, and after heavy rains in winter, the sands of the ravines contain gold. Remains of former gold-workings exist on the haciendas of Payen, the Cerros Amarillos, and Aculeo, and the whole claim extending from Algüe to the village of Peumo; only one mine, that of La Leona, near Rancagua, is now in operation. As far back as 1863, a committee reported no less than 175 gold-deposits in the provinces of Aconcagua, Santiago, and Colchagua, all within and west of the cordilleras of the coast, commencing at Chacabuco.

A recent (1878) writer in the *Mining Journal* (xlviii. 691) draws attention to "extensive deposits of auriferous gravel. From time immemorial, Chili has been a gold-producing country. The gold of the Incas was Chilian, and partly Bolivian. The Spaniards took immense quantities of gold out of the Chilian river beds, worked by the *batea* or pan by their allotments of Indians. From about the latitude of Coquimbo, and throughout the south of Chili, and within some 50 miles of the coast, a belt of auriferous gravel, from a few feet to several hundred feet thick, extends with various interruptions."

John P. Sewell, addressing the *Mining and Scientific Press* of San Francisco (Min. Jl., xlix. 225) in 1879, says that, from the Chilian historian of the time of the Conquest, we gather that the Chilian Indians paid a yearly tribute of 1400 lb. of gold to the Inca of Peru. Almagro, a Spanish officer, seized the tribute on its road to Cuzco; in it were nuggets worth $500 and $700 (100*l.* and 140*l.*). Immediately after the Spaniards founded Santiago, the capital, they commenced (A.D. 1549) to work the gold-washings at Marga-Marga with Indians, and extracted such large amounts of gold that it was weighed in the steel-yard. At Quilacoya, the governor Valdivia employed 10,000 to 15,000 Indians, and pushed his conquests still further south, and founded the "Seven Cities" in order to work the gold-washings at Aranco, Angol, Canete, La Imperial, Valdivia, Osorno, and Villarica. There are abundant data to prove that the gold-washings were worked on an immense scale by the early Spaniards. Sewell states that the work was done almost entirely in the river-beds, and perhaps some ground-sluicing; but that the beaches (? benches) are untouched: thus contradicting Schmidtmeyer and Darwin. It appeared impossible, both to foreigners and natives, that such an extensive gold-field at Marga-Marga, 10 miles long by 5 miles wide, could exist almost at the outskirts of Valparaiso, the principal seaport of Chili, without their being aware of its value. He mentions the Niblinto washings, near Chillan, and the washings at Caren, as about to be worked; and notices a point of difference between the Chilian and Californian gold-washings, in that the former are located west of the coast range, and near the sea, at the outlet of some stream or river, and extend from the Straits of Magellan up to the city of Copiapo. The coast range is traversed by numerous gold-ledges, which appear to have been the sources of the gold-gravels. Sewell opines that the dead rivers must have run from Magellan Straits to the north and on the west of the coast range, since the gravels are deposited on that side, all close to the coast, and in every case traversed at right angles by the live streams running into the sea. These remarks refer to the central portion of Chili, between Coquimbo and Concepcion. In the southern or Indian territory, it would appear that gold is found right across from the foot of the Cordillera to the coast.

Andacollo, 35 miles from Coquimbo, has long been famed for the quantity of gold said to exist over the district; but on account of the scarcity of water, it is difficult to collect, though small parties of washers make a livelihood by washing the soil. The gold is of a reddish colour, and is used in the country. The great mine of Los Cristales, at Canquenes, was recently said to have been rediscovered, and other ancient workings are attracting new attention.

This section cannot be concluded without making special reference to the exhaustive work just published by our countryman B. Vicuña Mackenna, on 'La Edad del Oro en Chile,' which deals with the gold-washings and workings from the time of the Incas down to the present, and fully discusses the questions of local mining laws and a gold coinage. The book is too bulky (nearly 500 pages) for convenient summarizing, and should be studied at length by all interested in the subject. See also Appendix A.

COLOMBIA (UNITED STATES OF) OR NEW GRANADA.—The gold-production of this confederation from 1537 to 1875, is thus stated by Dr. Soetbeer:—

Period.	No. of Years.	Total.	Annual Average.	
		lb.	lb.	£
1537–1544	8	35,200	4,400	279,000
1545–1560	16	70,400	4,400	279,000
1561–1580	20	88,000	4,400	279,000
1581–1600	20	88,000	4,400	279,000
1601–1620	20	132,000	6,600	418,500
1621–1640	20	132,000	6,600	418,500
1641–1660	20	154,000	7,700	488,250
1661–1680	20	176,000	8,800	558,000
1681–1700	20	176,000	8,800	558,000
1701–1720	20	220,000	11,000	697,500
1721–1740	20	220,000	11,000	697,500
1741–1760	20	220,000	11,000	697,500
1761–1780	20	176,000	8,800	558,000
1781–1800	20	198,000	9,900	627,750
1801–1810	10	110,000	11,000	697,500
1811–1820	10	66,000	6,600	418,500
1821–1830	10	70,400	7,040	446,400
1831–1840	10	72,600	7,260	460,350
1841–1850	10	74,800	7,480	474,300
1851–1855	5	38,500	7,700	488,250
1856–1860	5	38,500	7,700	488,250
1861–1865	5	38,500	7,700	488,250
1866–1870	5	38,500	7,700	488,250
1871–1875	5	38,500	7,700	488,250
		Total.		
1537–1850	314	2,479,400		157,216,500
1851–1875	25	192,500		12,206,250
1537–1875	339	2,671,900		169,422,750

Schmidtmeyer alludes to the mines of Choco, on the western side of the Andes, as being one of the spots which have hitherto (1824) produced most gold in the west of America. The gold- and platinum-mines of Choco are said to be on some of the affluents of the river Atrato, and its sands are still auriferous. Mollien (1824) says that Santa Fé receives a considerable quantity of gold from Pampluna and Giron, the latter being the purer.

Lloyd (1833) states that in Panama proper, only 2 gold-mines are worked, Santa Rita and Pequeni; but their produce is insignificant. They are in the mountains near Porto Bello. In Veragua, including Choco, a considerable quantity of gold is obtained by washing; it is chiefly got by a few proprietors of slaves, or by free Indians, "who employ one portion of the year in collecting the alluvium from the bottoms of the rivers and piling it in heaps, a second in washing it, and the remainder in spending it."

In 1850, Ed. Cullen wrote to the *Mining Journal* (xx. 237) an account of an excursion he made into the forests of Panama, and "found that gold was to be obtained by washing the earth on the sides of the mountains, on the banks of the streams, and in the crevices between the ledges of rock in their bed." In the neighbourhood of Malineca, near Yavisa, on the river Tuyra, or San Maria, the capital of the territory, he found gold abundant in the streams, and the quartz rocks rich with it; he dug upwards of 3 lb. of it, 22 carats fine. Mining, he says, was carried on by the Spaniards formerly; and he read in the archives of the Treasury of Panama, that the king's tax of 5 per cent. from the single mine of Cana, the Mina Real in the Cerro del Espiritu Santo at Santo Crux de Cana, amounted to upwards of 3½ millions of dollars (729,166*l.*) per annum, giving upwards of $70,000,000 (14,583,333*l.*) per annum for the produce! All mining operations in Darien were stopped, and the mines closed up, by a decree of the King of Spain, dated the 12th of March, 1685, in consequence of the repeated incursions of the buccaneers, and the interruption which the commerce of the Spaniards suffered from their vessels cruising in the Gulf of Darien. Since that period they were never reopened.

Dunlop (1852) says that the Indians among the mountains and hills, wash gold in most of the streams of the Isthmus; but this also has partaken of the unenergetic and lazy character of the Spanish creole character, and those versed in such affairs think that much larger returns could be obtained by the application of skill and regular labour. Long ago the Spaniards used to mine and wash gold very successfully on the Isthmus, both near Costa Rica, and southward of the Darien; but Peru and the more distant auriferous districts tempted them to relinquish all others for the time, and subsequently, when the revolution of Colombia disorganized these realms, and changed the system of labour by abolishing slavery, the Darien and Panama diggings were gradually abandoned, and it is only quite lately that any, saving the Indians, have turned attention to them. Whilst at Panama, he often heard of gold-digging expeditions to the streams and mountains in the vicinity; but California was so easily reached by all in quest of ore, that comparatively few, save native gold-hunters, were of the parties. The gold-mining and -washing throughout the Isthmus is a very important feature in its prospects. The government are willing to give easy concessions, and such adventures could be started with all facility, since the first attempts might be made near Panama or Chorèra, and with comparatively little expense and no danger; and even although not lucrative at first, the quartz on the higher ground would repay labour, for the streams all contain more or less gold washed down from the hills.

Captain FitzRoy (1853) remarks that in the early days, so famed was Darien for gold, that the province was called "Golden Castile" (Castilla de Oro); it was the principal portion of that Tierra Firme, so famed afterwards as the Spanish Main, the real El Dorado to which Sir Walter Raleigh went in 1517–18, Sir Francis Drake in 1557, troops of buccaneers in the 17th century, and the Scotch colony in 1698. Repeated aggression on this auriferous district, where abundance of gold was procured by black slave labour, after the aborigines had been diminished in numbers by oppressive cruelties, induced Spain to close and abandon the mines for a time (early in the 18th century), even those famous ones in the mountains of Espiritu Santo, near Cana, from which alone more gold went through Panama in a year than from all the other mines of America taken together. These Cana mines were sacked in 1702 and 1712 by the English, in 1724 by the French, and by the Indians in 1727. Nevertheless in 1774, mining operations were again going on, having been re-established a few years previously. When Cana was taken by the expedition (as narrated by Davis) sent from Jamaica, by Col. Beckford, in 1702, there were about "900 houses" (probably most of them mere huts); therefore the population could hardly have been less than 3000 at that date. Since the time when Spain lost her American dominions, New Granada has included Darien; but the aborigines have held their ground on the Isthmus. No mines have been regularly worked. A few gold-washers only have frequented the rivers in the dry season. The very sites of villages, and the actual localities of mines, have been overgrown by the thick underwood of tropical vegetation; and, except by tradition among the Indians, their places are forgotten. According to the old Spanish boundaries, the province of Panama is separate and distinct from that of Darien. A French company has lately obtained a grant to work gold-mines on the Marea river, and, among other parties, are earnestly striving to monopolize the Cana district, whence so much gold was carried formerly.

In the *Mining Magazine* of Sept. 1853, p. 284, it is stated that the gold of Antioquia is 20 carats fine, that of Choco 21, and that of Giron 23¾.

J. H. Smith (1854) records that the mountains, after following a course from south-east to north-west, as far as the volcano of Chiriqui, turn to the north, sending down towards Punta Burica a range of broken ridges and spurs of lower hills. Traditions speak of the auriferous richness of these lands. The gold-mine of Tissingal, which gave name to the adjacent coast of Costa Rica, was one of the richest ever worked by the Spaniards. This mineral deposit was behind the volcano of Chiriqui, and among the range of the spurs of the Cordillera, forming the northern limits of Burica. Not long since, an Indian from the vicinity of the volcano came to the town of David (the capital of Chiriqui), and sold two lumps of gold weighing 1 lb. each. The celebrated mines of Estrella are familiar to readers of the early discoveries by the Spaniards. It is well known that there existed gold-mines in the vicinity of the Mosquito coast, which in former times extended as far as the Bay of Almirante and lagoon of Chiriqui on the Atlantic. The Mosquito Indians, who were in continual warfare with those of the mountains and plains on the Pacific side, finally overthrew the latter, destroying their mines, the precise localities of which have been lost since then. From these accounts, it may be inferred that the gold found in the ancient graves must have been procured in the territory where those Indians dwelt. Gold has been found in the mountains, ravines, plains, and streams which run into the Pacific, particularly at Guanavano and Charco Azul. On the road from Costa Rica to this province, an extensive quartz formation has been discovered at Las Breñas. It is a common occurrence for the Indians of Terrora to visit this spot, to grind the rock and extract gold.

Holton (1857) alludes to the gold-deposits in the vicinity of Piedecuesta, at head of the river Lebrija, which empties into the Magdalena, in Pamplona province; and states that the gold-washings of Choco cannot be worked by whites, and the free negroes will not work. Also on the road from Cali to Vijes, Buenaventura province, is a hacienda called San Marcos, where, up a small stream, are found numerous auriferous veins of quartz. It is only about 20 miles down the valley of the Dagua to the port of Buenaventura. In a spur of the Caldas chain, close to Vijes, are gold-veins or deposits, and a mill for amalgamation is being built. There are also gold-washings.

De Puydt (1868) declares that, as for gold, it is on record that the Spaniards greatly enriched themselves by working mines of that precious metal in the Darien ; and he is "enabled to state positively that almost all the rivers—particularly on the Pacific slope—waft down either gold-sands or gold-agglomerations of larger or smaller size."

When Captain Bedford Pim was in Panama (1869), the great topic of the hour was the gold-mines of Barbacoas, a place up the river Tumaco, on the west coast of South America, nearly under the Equator. One of the mines there in successful operation had produced 400 lb. weight of gold since Dec. 1865. The gold is of fine quality, and so is called "float" gold, that is, flat and thin. The white men, from exposure, want of food, and climatic disadvantages, were dying like rotten sheep. The general conviction was that the poor man, whose whole fortune consisted in mining implements, would not be much bettered by going to Barbacoas ; but that powerful companies might be able to turn the mineral wealth of the locality to good account.

F. A. A. Simons (1881) states that the sands of the Rio Dibulla, a good-sized stream, springing from Mount Chirua, the sacred mountain of the Arhuacos, and flowing into the Caribbean Sea, are highly auriferous, and he believes would repay working for gold. Gold abounds also in the sand of the Rio Sevilla, which flows from the eastern side of the Sierra Nevada de Santa Marta, into the river Frio, which latter empties into the Ciénaga Grande lagoon, communicating with the Caribbean Sea. In reference to this, C. R. Markham has observed that the Sierra Nevada de Santa Marta was the scene of one of the most remarkable episodes of the early Spanish conquests in America during the 16th century. When Charles V. wanted to colonize Venezuela, and to discover El Dorado, which was supposed to be a kingdom teeming with gold, in the very centre of South America, he made a grant to a powerful mercantile house, the Velsers of Augsburg, of the whole country from Rio Cesar to Marcapana, and as far to the south as they could conquer. They sent out a German adventurer named Alfinger, who landed at Coro, and at the head of about 200 Germans and Spaniards, with a great army of Indians, marched down the valley of the Cesar until he came to the junction of the Magdalena. There he found a people so enormously rich in gold that he loaded a number of his Indians with it, and sent them back to Coro, with an intimation that he should remain where he was until he received further supplies.

The *Panama Herald* of Aug. 3, 1851, alludes to the rich gold-mines in the vicinity of Choco, from which large quantities of gold-dust have been sent from the port of Buenaventura to Panama and Europe, as being easier of access than any others. The most extensive mining on the Isthmus is carried on in the neighbourhood of Quibdo or Cibera. On the Rio Andagada, a branch of the Atrato, about 2 days' pull above Quibdo, are said to be rich mines, which have not been taken up ; also in the neighbourhood of Noveta, which is situated above Cibera. On the Rio Bebera, about 15 miles below Quibdo or Cibera, are also good mines, which are easy of access. High up the rivers, surface gold is found in quantity; lower down, it is found at considerable depth, and much of the top earth has to be removed before it is accessible. In the interior are good diggings high up in the mountains. Gold undoubtedly abounds in the interior of the Isthmus, within a few miles of this city; but great difficulties have to be overcome before the mines can be worked with profit, such as the high price of provisions, and want of roads or even paths.

Old Methods of Washing for Gold.

A very able and interesting account of the manner of washing gold by the natives of this country was published in the *Mining Magazine*, Oct. 1856, pp. 303–8. It may be summarized as follows.

The instrument used by the native alluvial gold-washer, called *almocáfre*, is peculiar in its form and construction. The blade of this instrument has a semi-elliptical shape, is about 9 in. long and 2 in. broad at its base, with a gradual taper to the point, which is blunt. The shank, which is in a direct line with the long axis of the instrument, is cylindrical, and receives a handle about 8 in. in length. With this implement, which is made of tough, well-tempered steel, the gold-seeker scrapes and digs among the boulders in the streams, and in the cracks and crevices of the strata everywhere. He has another implement for testing the quality of the earth or sand to be washed. It is a boat-shaped piece of horn, named *cacho de bateador*. In this he collects a small quantity of the material to be tested, and by repeated levigations with water, which is allowed to flow off afterwards slowly, the lighter and soluble portions escape, leaving behind the metal with its metalliferous associates.

When a locality is found sufficiently rich for washing operations, the loose earth, pebbles, and sand are scraped together, and if water is present, the larger pebbles and stones are carefully washed and thrown aside. The material thus collected is put into a wooden bowl (called by the natives *batea*), taken to a stream or pool of water, and there washed.

The *batea* of this region is peculiar also. It is conical in shape, and has 2 short projections from the brim, about 2 in. long, and opposite to each other, which serve as handles. The cavity of the bowl terminates below, in a point, but the outside is slightly truncated. The *batea* is made from the mountain cedar, and is light and strong. The method of using it is much the same all the world over, and needs no special description here.

The working of veins, since the Spanish rule, has almost been abandoned, not being as profitable as the gold-washings, because of the rude, tedious, and imperfect methods of extracting the ore and separating the metal. The Spanish mode of grinding the ore, by manual labour, between two small stones, which, under any circumstances, must have been a losing operation, was rendered almost an impossibility, on account of the matrix becoming so hard as to require efficient implements to extract and pulverize it. For this reason, undoubtedly, all the excavations in veins have only penetrated a few feet below the natural surface, and rarely ever into the compact portion of the matrix, although the Spaniards must have been convinced from the explorations they did make, that the ore increased in richness as they descended into the vein.

The native of the present day is well satisfied with washings from an auriferous stream of a few oz. of wash-gold; and, with his characteristic apathy, never attempts to make an excavation in a newly-discovered vein, or in search of a deposit of *oro corrido* or wash-gold, excepting now and then a narrow tunnel or "lead" into a hill, where he is oftentimes richly repaid for his labour. The tunnels, or *guacas*, as they are called, have been sources of great wealth to the gold-digger of this region, especially during the time of the Spaniards; and they constitute a large proportion of the excavations in this vicinity. The most unquestionable proofs still exist of the abundance of wash-gold in the hills of Cocuyos, Guinea, Zapaterito, and Barrera.

In former times, the rivers of Santiago, Concepcion, Barrera, Zapaterito, San Antonio, and San Bartolomo were those most noted for their gold-washings, and they are the principal streams that yield the most satisfactory returns to the gold-washer of the present day. In these rivers are many deep pools and eddies, where, from their depth, neither the Spaniard nor the native has been able to wash the auriferous beds at the bottom. One of these localities in particular is the lower falls of the San Jago, where, there is every reason to believe, an immense deposit now exists; for within the last two years, exceedingly rich washings have been made from the earth taken at the margin of the pool below the falls. The washings of a single *batea* full of earth, are said to have given 1 lb. of gold, and many successive bowl-washings have yielded each from 1 to 3 and 4 oz. of fine gold. At different times, attempts have been made to wash the shallow portions of this basin; but the depth of water has been too great for the rude methods adopted.

The method of collecting the auriferous sand and detritus from the beds of the deep pools in the rivers and streams is by diving, and scraping it together with the *almocáfre*, and thus loading the *batea*, which they bring up from the bottom, and, after carrying it to a convenient place, wash the contents. The contrivance of the native for keeping himself at the bottom of the pool while engaged in collecting the detritus and sand from among the boulders and out of the crevices in the formation, is very rude, but effective. It is as follows:—He selects an oblong quadrangular stone of the requisite weight, say about 10 to 12 lb. One side of this he makes concave, to be adapted to the nape of the neck, and then about it he works a netting of *bejuco*, which is the natural rope of this country. To this he attaches a broad flexible band of tough bark by both of its ends, and of such a length as to be slipped readily over the head from behind forwards as far as the forehead, while the stone is resting upon the nape of the neck. With the stone thus arranged upon his neck, and armed with the *almocáfre* and *batea*, he cautiously wades to that depth where he can retain his foothold with his head above water; then, throwing himself forward into the water, the weight of the stone bears his head downward to the bottom of the pool. Here he secures the *batea* stationary by putting a stone into it, and then groping about, with *almocáfre* in hand, he scrapes together the auriferous sand and fills the *batea*. Before his *batea* is loaded, the diver is compelled, perhaps several times, to rise to the surface for fresh air; and this he does by slipping the band from his forehead and casting off the stone. After rising to the surface, he swims to the place where he can gain his foothold as before, and then drawing towards him the stone, by means of a cord attached to it, he replaces it upon his neck, and after he is sufficiently refreshed, dives in the same manner again. The *batea* is necessarily always retained where the depth of the water is not greater than the diver's height, as it would otherwise be impossible for him to raise the *batea* full of sand and detritus. By this rude and tedious management does the gold-washer obtain the gold from the bottom of the pools, which have not, generally, a greater depth than his own height. In some instances, however, the beds of pools of considerable depth have been partly washed by some natives more daring and persevering than the rest, where the great abundance of gold has been an inducement. In these cases, the diver only attempts to collect some lumps of gold from the crevices in the strata, and from among the loose rocks, or to gather a small quantity of auriferous sand in a *tortuma* or gourd, which is repeatedly emptied into the *batea* on the bank, and, when a sufficient quantity is collected, is there washed.

Old diggings, mines in veins, tunnels into the hills, and, in fact, every variety of excavation, are to be seen in great numbers in these regions, and particularly in this section. The extensive workings in the mines of Vela Solida and Vela del Rey conclusively testify to exploration and mining on a large scale in former times, and with considerable intelligence and energy. But for the last 25 years, the gold-washings even have gradually declined, until at the present time, only 100 lb. or so of wash-gold are obtained annually by the very few natives now engaged in this vicinity. Some 25 years since, an enterprising New Granadian, Juan Lopez by name, worked somewhat extensively in the old mines and excavations of the Spaniards; but as far as known, he carried on his mining operations with no additional improvement upon the old Spanish system, nor did he advance much farther in his various explorations than the Spaniards originally. He worked principally in the outcroppings of the veins, and drove leads into several hills for deposits of wash-gold; yet in a few years' labour he amassed immense wealth, which he and his family succeeding him have managed to nearly dissipate in a few more years.

The so-called *guacas* of this region are very interesting objects for examination and scientific inquiry, on account of the novel geological conditions attending the presence of gold, which are exhibited by them. These *guacas* penetrate the hillsides at various elevations, differing greatly in their extent, and varying exceedingly in many instances from the horizontal direction. There are, however, several circumstances which are found associated with these excavations without exception, and some of them are undoubtedly the indications which lead to the selection of the locality, and govern the course and extent of the *guaca*.

At whatever elevation on the side of the hill the excavation may be, the opening is always at a considerable distance below the summit of the hill; and as the general direction of these tunnels is the horizontal, they penetrate the body of the hill at greater or less depths below the natural surface. The indication which governs the selection of the spot for commencing a *guaca* is the presence of a stratification called by the natives *peña*, and a detritus, either superimposed or partially mingled with the upper portion of this stratum, which yields gold. This deposit of auriferous detritus varies exceedingly in extent, but when it is confined to a few feet in breadth and thickness, it is styled a *venero*, or vein. The stratum called *peña* is felspar or gneiss decomposed to a greater or less degree in its upper layers, which, coloured by iron sulphates, present different shades of blue. As one descends in these strata, they become more compact and hard; and in no instance is gold found below the extent of decomposition and consequent dissolution in these strata. The vein or auriferous deposit is composed of boulders of trap, greenstone, gneiss, and felspar; detritus of every description of rock belonging to this region, and decayed vegetation, such as trunks of trees and fruits, some of which have lost entirely their vegetable matter, and are impregnated with aluminous earths; while iron-pyrites, magnetic sand, and crystallized quartz, and lastly, by far the most important ingredient, gold, in large quantities, fill the interstices. Above the auriferous deposit is superimposed a layer of porphyroidal clay, of no great thickness generally, which is variously coloured by iron and its compounds. This layer is styled among the native miners here "*sepé*," and is not unfrequently absent, or of very limited thickness. Above this layer comes a stratification, which, from its position and character combined, presents an interesting geological phenomenon worthy of especial attention. The name given to this latter by the natives is *tosca*. It seems to be of volcanic origin, having been evidently superimposed upon the *sepé* when in a molten state. It has many of the characteristics of lava, and would seem to have been the result of volcanic action while the surface of this region was submerged below the level of the sea.

This *tosca* is of varied thickness and extent, in some places reaching the surface, and frequently making a stratum which extends throughout the body of the hill, overlying the *sepé*. In some *guacas* it forms the roof for their entire extent; and its presence is considered one of the most favourable indications of the existence of gold in the *venero*.

In most instances, the *tosca* is covered by diluvium and alluvial earth, to a greater or less thickness, forming the summits of the hills. Now and then, however, the *tosca* comes out to the surface on the plateaux of the *guaca* hills. This is the case on the Cocuyos hill, one of the most celebrated of these eminences, where it may be seen and traced to considerable distances. The auriferous deposits in these *guaca* hills vary greatly in extent and disposition, as already remarked. Sometimes there is no distinct and uniform *venero*, but the deposit is distributed irregularly in layers of different thickness and limits, with interruptions like "faults" in a vein of quartz, composed of the layers of *peña* and *sepé* interposed in juxtaposition. This occurs generally when the deposit is located deep in the hill.

A vast amount of detailed information is scattered through the reports of the Directors of the Colombian Mining Association, and Mariquita and New Granada Mining Company, for a sight of which the author is much indebted to the present successors to the properties, Messrs. Powles and Rogers. The general facts recorded in these reports only confirm what has already been said, and it would needlessly occupy space to reproduce them.

ECUADOR.—Pritchett (1860), from his own observations, and from the trustworthy information of others, confidently asserts that the lower alluvial slopes of the Andes, which gradually subside into the great Amazonian plain, all contain gold, from the sources of the Napo, on the north, to the Marañon, above the Pongo de Manzeriche, on the south, perhaps nowhere in very great quantity, but still amply sufficient to be worth the trouble of working. In his voyage hither, his party began to encounter beaches strewn with pebbles of granite and quartz, at a little less than half-way up the Bombonaza, on the ridges and in the valleys; the pebbles gradually became larger and more numerous as they ascended, and were always accompanied by gold. In fact, throughout the Upper Bombonaza one can hardly scrape up the quartz gravel to the depth of a foot without encountering small fragments of gold. Near those streams where gold is known to be most abundant, the loose, wet gravel extends to a great depth; through this the larger pieces of gold gravitate by their own weight, and are to be found if searched for; but as the Indians only wash the surface gravel, scraping it up merely with their hands, it is not to be wondered at that they rarely find a nugget.

It would in Pritchett's opinion undoubtedly be worth while to explore the mountain Llangañate, from the snows of which comes down the turbulent Topo, where rocks with quartz veins, and even blocks of pure quartz, are copiously strewn. The tradition that gold has been got out of this mountain in the time of the Incas is so universally diffused that it can hardly be altogether without foundation. In it are the sources of the Curaráy (a tributary of the Napo), the Bombonaza, Topo, Verde, Shuna, and many other rivers, whose banks show quartz and gold. In connection with this point, it may be mentioned that Dr. Villavicencio, in his Geography of Ecuador, refers to a Spaniard who became suddenly rich, and who at his death asserted that Llangañate had been the source of his wealth. His confession was duly registered in the archives of the city of Latacunga; and some years ago, Dr. James Taylor, in his memoir on the 'Eastern Gold Fields of the Andes,' mentions their great importance and immense extent.

In 1866, Col. Neale reported the discovery of unworked and hitherto unknown gold-deposits in the district of Esmeraldas.

Orton (1876) generally bears out Pritchett's statements, adding that the prevailing rock on the eastern side of the Ecuadorian Andes is mica-schist, and that the name of the Curaráy river is probably derived from *curi* (gold).

GUIANA (BRITISH).—Gold was discovered at Tupuquen, on the Yuruari, a tributary of the Cuyuni, in 1857, and on the British side of the Cuyuni itself, about 40 miles up, in 1863. The working has not been successful, and has given rise to complications with the boundary question (see Proc. R. Geogr. Soc., ii. n.s. 52–3).

GUIANA (DUTCH) OR SURINAM.—Gold-digging commenced here in earnest in 1875, after Alma's journey to the Commewyne, near the French border, where the first start was made. Subsequently an expedition sent to trace a new road from the Fall of Brokopondo, above

Surinam, to the Fall of Predosengoe, opened up other auriferous lands; and concessions covering nearly 300,000 acres were allotted. One of the richest spots was a placer on the Saramacca River, about 125 miles from Paramaribo. A report on this locality by G. A. Taylor, published in the prospectus of the Surinam Gold-mining Co., gives the following information. The ground in the creeks consists of: (1) top soil of yellow clay, 1 ft. and upwards; (2) sand and gravel, 1 to 6 ft.; (3) clay of unknown depth. The sand and gravel pays well at top, growing richer in depth and reaching its maximum yield along the surface of the lower clay. The gravel in the creeks is scarcely at all water-worn, showing the proximity of its source. The clay has not been penetrated, nor have the surrounding hills been tunnelled. The product is stated to reach ½ lb. to 4 lb. of gold daily from each long-tom; if so, it is puzzling to know why the proprietor sold it to a company.

A recent Consular Report (1878) has the following remarks:—

"The only branch of industry worth noticing is the exploration of gold, and its development increases marvellously. This metal seems to abound in the colony. In every district where it has been sought for, it has been found in larger or smaller quantities. The opportunity given by Government to rent land at the nominal price of 10c. (2*d.*) per *hectare* (2½ acres) per annum is an inducement to almost every one to test their fortune in the gold-fields. The gold is obtained by a primitive process of washing with sluices and long-toms, and is found in the alluvial deposits. The report for 1877 shows an increase of the value exported, during that year only, by the steamers of the Compagnie Générale Transatlantique, as compared with 1876, of 251,000 florins (20,916*l.*); and during 1878, 407,059 florins' (33,921*l.*) worth has been exported by the same conveyance, against 343,780 florins (28,648*l.*) in 1877; but the amount really found is difficult to ascertain, as parties conceal the results of their explorations. No export duty being leviable thereon, the total value exported otherwise remains unknown, as would that shipped by the French steamers, were it not done through the intermediacy of the Surinam Bank, which advances a certain amount to the parties for their gold, to enable them to continue their expeditions, and ships the same to Holland. The sum advanced by the bank nearly amounts to the value of the gold, and the commission charged for its interference is 1 per cent. For the year 1879, the export thus recorded reached 700,000 florins (58,333*l.*). The nominal rental received by the Government was 19,760 florins (1646*l.*) in 1878, and 34,678 florins (2889*l.*) in 1879."

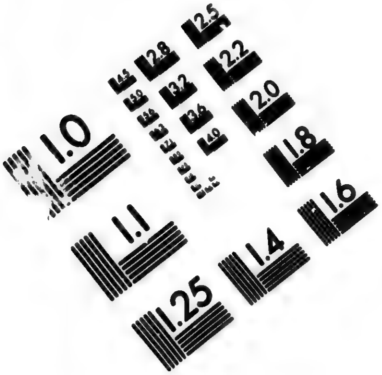
GUIANA (FRENCH) OR CAYENNE.—What little information exists concerning the auriferous wealth of French Guiana is mainly due to our Consular Reports, and to the accounts given by mining experts sent out for the purpose by companies. One report stated the average yield of gold per month during the year 1875 at 9427 oz., a mine at Sinnamary having produced a nugget weighing nearly 2 lb. New finds were being recorded at Iracoubo, Mana, and Maroni; and the streams called Oyac, Orapa, and Comté were reported to have numerous placers along their banks. A consular report for 1878 said that Mana produced 21,747 grammes (say 48 lb.) of gold in March 1877, and 39,662 grammes (say 88 lb.) in April. The diggings at Pas-trop-tôt, in the district of Mana, afforded over 300 lb. of gold in the 6 months ending Aug. 31, 1879. Crévaux considers that the Tumac Humac range is not the only source of the gold, but that the lower chain running through the colony contains most of the gold which is found in and along the creek.

The following details are gathered from a report by Oliver Pegler, A.R.S.M., upon the Pas-trop-tôt placer, addressed to the Mana Gold Co.

The concession is situated in the south-west portion of French Guiana, between the rivers Mana and Maroni, at a distance of about 125 miles from the coast. The geological character of the country is metamorphic—Silurian rocks, abounding with trap and more recent eruptive formations. The gold-bearing deposits at present known and worked are of very limited area, being confined to the deeper beds of the ravines and creeks, which in extent may be estimated at 1 per cent. of the total area of the concession. The system employed for extracting the gold from the auriferous earth, by the natives, consists in an extremely rude process of washing; no machinery is necessary, and plenty of timber abounds for constructing the sluices. The bed of auriferous earth rests mostly upon a stratum of clay, and is of varying thickness, from 2 or 3 in. to 3 or 4 ft., the average thickness being 13 in. The over-burthen, or superincumbent crust, consists of clay covered with a layer of decayed vegetable matter, and is also of varying thickness. The average may be taken at about 5 ft. This auriferous bed is composed of quartz fragments, and other mineral resting on the clay, with fine sand above; thus the gold, owing to its high specific gravity, is found in greater quantities in the deeper and coarser portions of the bed.

PARAGUAY.—According to Keith Johnston (1875), gold has been found in Paraguay, but in quantities too small to repay working, though sought for diligently by experienced men in all likely districts.

PATAGONIA.—Gold is washed in Patagonia in a stream near Punta Arenas, the capital of the Chilian colonial territory of Magellan, in Brunswick peninsula, Straits of Magellan. The natives offer it for sale in laminated grains and scales, against its weight in sovereigns. Assays of it by C. L. Claude, of Valparaiso, gave:—Gold, 91·760; silver, 7·466; copper, 0·248; iron oxide, 1·224; total, 100·698.



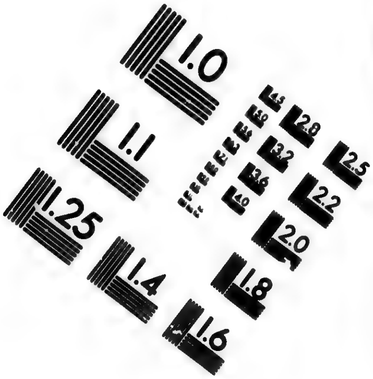
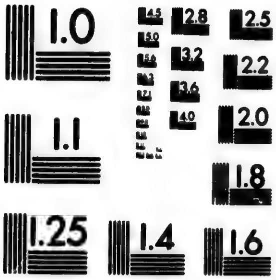
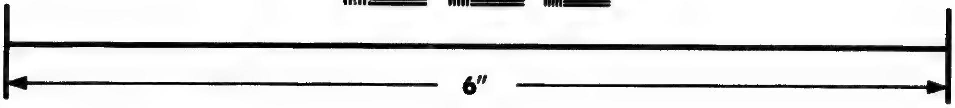
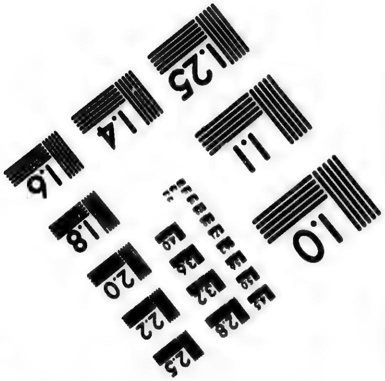


IMAGE EVALUATION TEST TARGET (MT-3)







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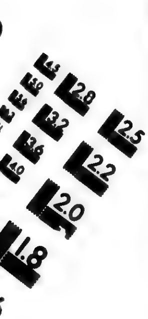
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PERU.—The gold-production of Peru in the years 1533–1875 is thus stated by Dr. Soetbeer:—

Periods.	No. of Years.	Total.	Annual Average.	
		lb.	lb.	£
1533–1544	12	18,480	1,540	97,650
1545–1560	16	10,560	660	41,850
1560–1580	20	11,000	550	34,850
1581–1600	20	11,000	550	34,850
1601–1620	20	22,000	1,100	69,750
1621–1640	20	22,000	1,100	69,750
1641–1660	20	22,000	1,100	69,750
1661–1680	20	22,000	1,100	69,750
1681–1700	20	22,000	1,100	69,750
1701–1720	20	22,000	1,100	69,750
1721–1740	20	22,000	1,100	69,750
1741–1760	20	22,000	1,100	69,750
1761–1780	20	26,400	1,320	83,700
1781–1800	20	28,600	1,430	90,675
1801–1810	10	17,160	1,716	108,810
1811–1820	10	9,900	990	62,750
1821–1830	10	7,040	704	44,640
1831–1840	10	9,900	990	62,750
1841–1850	10	13,200	1,320	83,700
1851–1855	5	4,400	880	55,800
1856–1860	5	3,850	770	48,800
1861–1865	5	4,400	880	55,800
1866–1870	5	3,960	792	50,220
1871–1875	5	3,960	792	50,220
		Total.		
1533–1850	318	339,240	21,510,900*l.*	
1851–1875	25	20,570	1,304,325*l.*	
1533–1875	343	359,810	22,815,225*l.*	

According to Markham (1862) upwards of $1,500,000 (300,000*l.*) came into the department of Puno yearly, either as payments for wool, or in salaries for officials, without counting the expenditure for the troops; and it is calculated that more than half this sum eventually finds its way into the hands of the Indians, who bury it. Thus, in considering the mineral wealth of Peru, the enormous quantities of coined money, the vases or other articles made of the precious metals, which have been buried by the Indians, must be taken into consideration; for this practice has been going on since the time of the Incas. Now that the currency consists almost entirely of the debased half-dollars of Bolivia, if a Spanish dollar or any other good coin is accidentally received by an Indian it is immediately buried.

In the beginning of the last century, a Jesuit found gold in a hill called Camante, in the Marcapata valley, situated between two ravines, in one of which, called Garrote, a Spanish company established gold-washings. The leading man of this company, named Goyguro, employed hundreds of Indians, and extracted gold from the Camante hill in lumps;

but one day an immense landslip fell into the Vilca-mayu, the chief stream of Marcapata, and all the workmen ran away and could not be induced to return. This was in or about the year 1788.

In 1836, a company was formed by several young adventurers, the chief of whom were José Maria Pacheco of Cuzco and José Maria Ochoa of Huara, with the object of again discovering the long-lost golden hill of Camante; but their expedition led to no practical results. In 1851, Colonel Bologenesi became the manager of an expedition for collecting cinchona-bark in the forests of Marcapata, during which, indications were met with of the ancient gold-washings.

Extending for a distance of 180 miles, from Marcapata to the frontier of Bolivia, is the watershed along that part of the eastern Andes known as the Snowy Range of Caravaya, where the numerous streams take their rise which unite to form the Ynambiri. The Madre de Dios, Marcapata, and Ynambiri are thus the great sources of the Purus. The tributaries of the latter drain the province of Caravaya.

The first mention of this region, continues Markham, is to be found in the pages of the old Inca historian, Garcilasso de la Vega, who says that "the richest gold-mines in Peru are those of Collahuaya, which the Spaniards call Caravaya, whence they obtain much very fine gold of 24 carats, and they still get some, but not in such abundance." The Jesuit Acosta also mentions "the famous gold of Caravaya in Peru." After the final overthrow of the younger Almagro, in the battle of Chupas, in 1542, some of his followers crossed the snowy range, and descended into the great tropical forests of Caravaya, where they discovered rivers whose sands were full of gold. On the banks of these rivers they built the towns of Sandia, San Gavan and San Juan del Oro; large sums of gold were sent home to Spain, and the last-named settlement received the title of a royal city from Charles V. In 1553, these settlers received a pardon from the Viceroy Don Antonio de Mendoza, in consideration of the gold they sent home to the Emperor. It is said that they sent him a nugget weighing 4 *arrobas* (129½ lb.), in the shape of a bullock's head; and that afterwards another nugget, in the shape of a bullock's tongue, was sent to Philip II., but that the ship which carried it was lost at sea. Eventually the wild Chuncho Indians of the Sirineyri tribe fell upon the gold-washers, and overpowered them. In the following century certain mulattos occupied the gold-washings in Caravaya, and the king, as a reward for their labours in extracting treasure, offered to comply with any request they might make. The mulattos asked to be called Señores, and for the privilege of entering every town on white mules with red trappings, and the bells ringing.

The Spaniards long continued to extract gold from the rivers of Caravaya, and established coca-farms and coffee-plantations in some of the ravines formed by spurs of the cordillera. Gold, however, was the product for which Caravaya was most famous.

In 1615, the viceroy Marquis of Montes Claros spoke of the rich *lavaderos* or gold-washings of Caravaya; and his successor, the Prince of Esquilache, wrote a long report upon them in 1620. It appears that, at that period, the richest of the Caravaya mines was called Aporuma, and that it had then been worked for 15 years by a company of adventurers. These men, the chief of whom were named Quiñones, Frisancho, and Perez, had excavated very extensive works to drain off the water; and they petitioned the viceroy to grant them a *mita* of Indians to complete the works, for that thus the royal fifths would be augmented. In 1678, the yield of the royal fifths from the Caravaya gold-washings was at the rate of $806 (168*l.*) in 3 months. The town of San Gavan, with 4000 families and a large treasure, was surprised and entirely destroyed by the Carangas and Suchimanis Chunchos, on the 15th of December, 1767.

In 1849, Caravaya attracted notice as a land rich in the precious metal, and it soon became the California of South America. In July of that year, two brothers named Poblete, in searching for cinchona-bark, discovered great abundance of gold-dust in the sands of one of the Caravaya rivers, and the news soon spread far and wide. Up to 1852, crowds of adventurers, among whom were many Frenchmen, continued to follow in the footsteps of the Pobletes, but most of them returned empty, and the excitement has now died away.

In the warm valleys are to be found all the wealth and population of Caravaya. The population consists of 22,000 souls, almost all Indians; and the wealth, besides the flocks of sheep on the western table-land, is created by the produce of coca, coffee, sugar-cane, and aji pepper plantations, fruit-gardens, and gold-washings. Markham could obtain no reliable statements respecting the yield of gold.

It is supposed that the old Spanish town of San Gavan was situated near a river of the same name, about 20 miles from Aragon's estate. The site is now overgrown with dense forest, and it has never been visited since its destruction; yet it is believed that vast treasure lies concealed amongst the tree-covered ruins, because the attack of the Chunchos was sudden, and at once successful; they care nothing for the precious metals, and San Gavan contained a royal treasury, and was a central deposit for the gold of Caravaya.

Phara is a ravine on the eastern slope of the Andes, about 35 miles from Crucero. Here many gold-mines were worked by Señores Mulattos, and at no great distance is the famous gold-mine of Aporuma, in the ravine of Pacchani. Phara is on the road to the gold-diggings which were discovered by the brothers Poblete, and which attracted so many luckless adventurers between 1849 and 1854. They are at a distance of 15 leagues to the northward. The path lies along a long ridge, gradually descending for 6 leagues to a little hamlet called La Mina. Thence to the banks of the river Ynambiri, here called Huari-Huari, is a distance of 3 leagues, down a very dangerous road, covered with huge blocks of schist, and skirting along fearful precipices. For this distance the road is passable for mules. The river is 70 yd. broad, and is crossed by an *oraya*, or bridge of ropes, traversed by a sort of net or cage. On the other side, at the junction of the Huari-Huari and the golden river of Chaluma, there is a place which has been named Versailles by some French adventurers. From Versailles to the *lavaderos*, or gold-washings, is a distance of 6 leagues up a narrow forest-covered ravine; and, in this distance, it is necessary to wade across the river Chaluma no less than 53 times. At the end of this perilous journey is a place called Alta-garcia, where the *administradores* of the company of first discoverers were established in 1850. Thence to Quimza-mayu (3 rivers) is ½ league, and here the *lavaderos* commence. In this part of its course the river is called Taccuma. Many of the gold-seekers have been formerly engaged in the cinchona-bark trade, and know the country thoroughly.

The tributaries of the Chaluma, called Quimza-mayu, rise in hills completely isolated from the Andes, and their sands are full of gold, both in dust and nuggets. Immediately above the *lavaderos* rises a hill called Capacurco, and by the French adventurers, Montebello, formed of quartz and other primitive rocks, with rich veins of gold. Here Manuel Costas of Puno erected a house, and brought out machinery for crushing the quartz; but the undertaking failed through the badness of the machinery, and the immense cost and difficulty of transporting materials through such a country. A few adventurers, however, still continue to wash for gold in the Chaluma or Taccuma. In the part of its course above the *lavaderos*, this river descends rapidly from an isolated range of forest-covered, precipitous hills; and in one place its waters plunge down in a cascade, with a sheer fall of 40 ft.

The region known as San Juan del Oro, was once famous for its gold-washings; and here the royal town of the same name stood, founded by the fugitive Almagristas, and afterwards tenanted by the Señores Mulattos, but long since destroyed and abandoned.

The geological formation of Caravaya is composed of non-fossiliferous schists, micaceous, and slightly ferruginous, with veins of quartz. It is a portion of the extensive system of rocks which Forbes has grouped together as belonging to the Silurian epoch, and which extends almost continuously over an extent from north-east to south-west of more than 700 miles, forming the mountain chain of the Eastern Andes, continuous from Cuzco, through Caravaya to Bolivia.

The streams flowing from the Eastern Andes to the north-west of the Paucartambo system combine to swell the Ucayali, while those to the south-east of the Pablo-bamba fall into the Beni, one of the chief tributaries of the Madeira. The intermediate streams are the sources of the unknown Purus. They are all more or less auriferous.

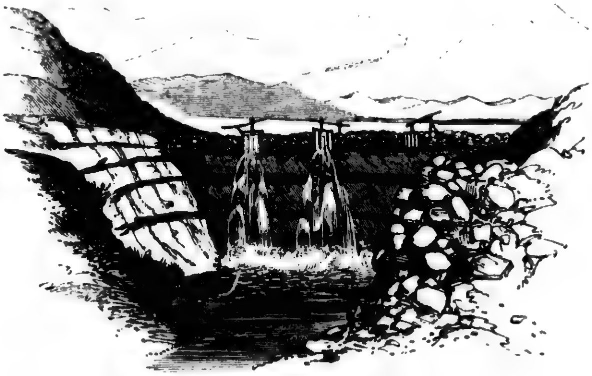
At Tipuani, in Bolivia, there is a very rich auriferous country, composed of blue clay-slates, with no fossils ; while the beds near Sorrata contain fossils, and consist of blue clay-shales, micaceous slates, grauwacke, and clay-slates, with gold-bearing quartz, metallic bismuth, iron-ore, and argentiferous galena. The whole of this Silurian formation is eminently auriferous, and contains everywhere frequent veins of auriferous quartz, usually associated with iron-pyrites.

Raimondi (Proc. California Acad. Sci., iii. 359) states that there are two principal ranges of the Cordilleras in Peru. The Western, or Cordillera of the Andes, divides the waters running into the Pacific on one side, and the Amazon on the other. The other chain is the Eastern Cordillera, which appears to be entirely composed of micaceous and talcose schists, metamorphosed by the elevation of the granites, and contains numerous veins of quartz, which in some places are quite rich in gold. Along the whole length of the coast, at a distance of 1 or 2 leagues, rises a small chain of hills, called Lomas (" the Hills ") formed of granite, syenites, and porphyries, and containing in scattered spots a little gold.

The same authority (Jl. R. Geogr. Soc., xxxvii. 134) states that the sand of the river Piquitiri is auriferous, and higher up, works were commenced having for object to give the water another course, so as to extract gold from the bed with greater facility. The owner of the farm of San José, having discovered the remains of these works, was induced to continue the search for gold in this river ; but, in consequence of the great difficulties that presented themselves, and the little profit, the work was discontinued. There is no doubt that the Piquitiri contains gold ; for his followers, having washed some of the sand, took out particles of the metal.

Forbes gives the following description of a local method of sluicing here adopted. The valley is, in the first instance, completely closed up, and the course of the river stopped by a rude wall or dam of stones, provided with sluices, and having a portion of the wall somewhat lower, in order to carry off any overflow of water, which otherwise might disturb the workings. A longitudinal excavation is then made close up to the one side of the valley, and of such breadth as can be conveniently carried on by the number of hands at disposal; and, in making this, the large boulders and stones, too heavy to be carried off by the rush of water, are piled up to one side, whilst the earth, gravel and clay are merely loosened and flushed off, by the water turned on from the sluices, allowing the force of the stream to carry them down the river. On arriving at the several successive auriferous beds, which are known from previous trials, and which are denoted by the dark bands running horizontally across the excavation, as seen in Fig. 6, more care is taken; but the whole of the auriferous earth is likewise flushed off, and, being so much heavier than the rest, deposits itself at but a little distance from the workings, where it is collected and subjected to repeated washing in a trough until nothing but the gold-dust remains behind. See also Appendix A.

FIG. 6.



MODE OF SLUICING IN S. AMERICA.

URUGUAY.—Our knowledge of the gold-fields of Uruguay is entirely due to Bankart, who, having in 1867 had his attention called to some Jesuit reports of the existence of gold south of Brazil, in the territory now known as the Banda Oriental, determined to carefully examine the northern portion of the Republic.

Starting from the highest revenue port (Salto) on the Uruguay, he took a nearly due east course, passing through the department of the same name for about 160 miles, without obtaining traces of anything but copper, lead, and iron. Thence he pursued investigations in the neighbouring department of Tacuarembo, between the 30th and 33rd parallels of latitude, and 54th to 56th degrees of longitude, where he met with a complete change. Granite and quartzose rocks of the primary formation, intersected by slate reefs in immense ranges, met the eye on all sides running into Brazil, most of them bearing in a northerly direction, and dipping to the east. On examining the sands and detritus at the bottom of the rivers Tacuarembo, Grande, and Chico, he found a little very fine gold; and, proceeding farther on the other side, came upon some alluvial deposits washed down from the surrounding hills, consisting of gravel, rounded quartz boulders, decomposed slate, sometimes 30 ft. deep, resting upon syenitic granite; this would, in many places, yield well with proper appliances. And at a place called Corralles, originally (from appearances) a lake having all around limestone, auriferous quartz, and slate reefs, he learnt that small *pepitas* or pieces of the precious metal are constantly met with, clinging to the roots of the palm-grass used for thatching purposes. No trial had as yet been made as to the probable deposits of gold below, for it is always a swamp. He heard that some years ago a Brazilian, with the aid of his slave, had washed out over 50 lb. weight of free gold, after 3 months' labour, from a dry creek not very far from this.

Proceeding to the spot indicated, he there saw the remains of their workings through the drift; and on searching the neighbouring hills, found several fine quartz lodes bearing N.N.W., and dipping E. He met with free gold here and there plainly visible to the naked eye, from which he took many samples, also occasionally auriferous pyrites below the surface; these lodes vary from 3 to 15 ft. in width. A piece of solid gold, weighing over 1 lb. (of 16 oz.), has been taken out of the quartz on the surface, and is in the hands of the Uruguayan Minister of War.

Here Bankart entered an open cutting about 6 ft. deep, and descended into a shallow well cut into the quartz, and was able to pick down rock which contained gold of a superior quality. Between these gullies and the quartzose hills, lay several flats, composed to some depth of gravel, rounded quartz, and slate; they will probably prove richer in metal than the adjoining creeks, which appear to be of more recent formation; but in all the gravel of the deep ravine which had been torn open by the floods, Bankart noticed an entire absence of small pieces of quartz, such as are found covering the slopes of the mountains or in the lower deposits of gravel. The quartz lodes are generally traversed by slate reefs, and sometimes run into or cease, when brought into contact with granite.

Here and there Bankart found shepherds squatting on the ground, engaged in turning up the surface for about 15 in., and breaking up the pieces of quartz with a hammer upon a stone mortar, setting aside such as contained visible gold, and rejecting the rest. By thus working for a few hours, they managed to collect a small heap of specimens, which they carried home; and, after accumulating a sufficient quantity, they calcined and pounded them, and amalgamated them with mercury in a *batea*. By this operation they obtained only the heavier gold, throwing away the rest as useless; the result gave them on an average about ½ oz. per working day. The gold thus extracted finds its way sometimes into Montevideo, but more generally to the Rio Grande, where it is no uncommon thing to meet with purchasers of 1 to 200 oz. at a time. The gold is of 4 qualities, ranging from 15 to 23 carats.

The ground here answers to the surface diggings of Australia and the placers of California, only the order of things is slightly reversed. In those countries the gravel was invariably washed to obtain the free gold, the quartz being thrown away; whilst in Uruguay the quartz alone is crushed, and the gravel is disregarded. No doubt some of the richest deposits lie in these accumulations, for wherever Bankart washed this drift, he invariably found gold in company with a large proportion of magnetic iron. His investigations led him to inquire if there had been no excavations made in the quartz-reefs; and in reply, he was shown various spots where shafts had been commenced, but relinquished after going 2 or 3 fathoms deep, on account of water. In all cases the rock had proved extremely rich, but the miners had no appliances whereby they could get rid of the water. Bankart devoted some weeks to testing the accuracy of their statements, and was enabled to return with a plentiful supply of very good stone. He pursued his researches for about 90 miles in length on the course of the lodes, and stretching 18 miles across them. Several lofty hills of magnetic iron were encountered, bounded by trap, and running into slate. And both in the gossan, and in the gravel at the base, he washed more or less gold in every pan.

Various assays made in England of picked specimens, gave the following results:—

No.		oz.	dwt.	gr.
1	Gold	87	16	16
2	Fine Gold	76	0	0
3	Fine Gold	81	16	14
	Fine Silver	18	8	14
4	Fine Gold	2992	11	0
5	Fine Gold	6512	18	0

Bankart anticipates an average of 2 oz. of gold per ton from the reefs. He discovered large and strong lodes of iron- and copper-pyrites associated with gold, evidently from the quartz and slate reefs that traverse them, extending for many miles, giving unmistakable evidences at the surface of the riches hidden below. The ancient workings have been abandoned evidently from excess of water, and from paucity of capital. These are situated only about 90 miles from the seaport of Maldonado.

VENEZUELA.—The following valuable tables concerning the gold-production, and general state of the gold-industry of Venezuela, are due to J. M. Muñoz (En. and Min. Jl., Apr. 12, 1879).

WAY-BILLS OF THE MUTUAL UNION TRANSPORTATION COMPANY OF THE MINING COMPANIES IN GUAYANA, VENEZUELA, FROM ORGANIZATION TO DECEMBER 31ST, 1878.

Date.	No. of trip.	25 stamps. El Callao.	25 stamps. Nacupi, O. Ex. and Mg. Co.	20 stamps. Hansa.	20 stamps. Potosi.	10 stamps. Chili, Mocupia and New York.	10 stamps. Caratal	
1874.		oz.	oz.	oz.	oz.	oz.	oz.	oz.
May ..	1	..	520½	..	95¼	151¾	763¾	..
June ..	2	..	585¾	..	222¾	89½	528¾	..
July ..	3	..	778¼	..	336	164½	1,014	..
Aug. ..	4	589	658	248¾	312½	204	1,382	..
Sept. ..	5	795	583	125	222¼	149¾	903¼	..
Oct. ..	6	640½	476	..	376	192¼	443	..
Nov. ..	7	338½	573¼	..	..	175	840	..
Dec. ..	8	622	1,032	..	..	214	968	..
1875.								
Jan. ..	9	399½	827¾	..	..	135¾	805	..
Feb. ..	10	444	1,606	..	962	205	803	..
Mar. ..	11	1,480	1,317	..	414	165	272	..
Apr. ..	12	1,239	1,203	..	265¾	165⅛	433¼	..
May ..	13	1,173	1,328	..	123	174	427¼	..
June ..	14	1,360¼	1,042¾	..	132¼	164⅜	336	..
July ..	15	1,280	1,131	..	120	265	318	..
Aug. ..	16	1,135	1,201	..	281	271¾	299	..
Sept. ..	17	1,331	820	..	312¼	355¾	322	..
Oct. ..	18	1,421	931	..	309	368	245	..
Nov. ..	19	1,382	1,023	..	..	325	231	..
Dec. ..	20	1,402	1,061½	..	..	405⅛	262	..
1876.								
Jan. ..	21	1,387	940	30 stamps.	..	193	242	..
Feb. ..	22	1,462	1,281	Panama	..	333½	270	..
Mar. ..	23	1,681	862	S.A.Mg.Co	280	374¼	230	..
Apr. ..	24	1,604	1,492	..	301	380¼	261	..
May ..	25	1,536	1,522	..	660	246¾	434	..
June ..	26	1,424¾	843¼	..	186	442¾	498	..
July ..	27	946	1,147¼	..	611½	284¼	601¾	..
Aug. ..	28	1,720¼	574	461¾	330	238½	512	..
Sept. ..	29	2,594¼	845½	458¾	150	347¼	620	..
Oct. .		3,994	1,334½	664¼	..	426⅞	268	..
Nov. ..		2,793	623¾	..	325	429¾	390	..
Dec. ..		1,682¼	258¼	957½	364½	332½	142½	..
1877.		40 stamps.	50 stamps.					20 stamps
Jan. ..	33	3,122¾	..	785½	424	225	..	Remington
Feb. ..	34	3,598½	..	..	430	402	..	Mg. Co.
Mar. ..	35	3,726¼	..	380¼	1,345	458	132	319½
Apr. ..	36	2,167	19	1,212	1,003¾	607	..	420
May ..	37	1,413¾	3,021¾	208	1,513	493	..	559¾
June ..	38	558¼	753½	..	1,444½	486½	..	299¾
July ..	39	1,103	619¾	626½	1,738½	481¼	..	382¾
Aug. ..	40	1,017	437¾	..	1,415	156	..	585½
Sept. ..	41	1,202½	..	..	1,611	261¾	..	..
Oct. ..	42	2,096¾	382	..	902	223	..	..
Nov. ..	43	2,300	586¾	..	1,050	454½	..	..
Dec. ..	44	2,156	490¼	461¼	1,800	303½	197½	..
1878.							20 stamps	20 stamps
Jan. ..	45	941¾	342	494¾	957	326	249¼	Nueva
Feb. ..	46	1,377¼	269	452½	808	401½	390¾	Hansa
Mar. ..	47	1,532	24	448½	348	316½	90½	27½
Apr. ..	48	1,905½	stopped	331	353	245	..	..
May ..	49	4,204	work.	..	346½	562¾	510	80½
June ..	50	5,034	..	..	924	1,003⅞	644	..
July ..	51	6,117¾	..	77¼	468	805½	100½	..
Aug. ..	52	5,428	..	..	663	639	421¾	120
Sept. ..	53	4,968	..	102	420	868	879	..
Oct. ..	54	3,964	..	174	209	756	632¾	..
Nov. ..	55	5,071⅞	..	..	621	568¼	111½	..
Dec. ..	56	5,465½	..	..	1,009	774½	503	..

Remarks.—This is simply the ounces sent by the companies in bars, averaging 915 thousand fine, or almost English standard, and worth, say $18 (3*l.* 15*s.*) net per oz. Much gold is carried every month for merchants and others not belonging to the Union, amounting to about on an average 500 oz. per month, not put down in the list above. Most of this is stolen from the mills by workmen; rest from hand-workings and placer.

Callao Co.—From the first trip up to the May trip No. 49, they ran a "middle mail," on their own account, on a contract that only expired April 1878. Therefore, it is but fair to calculate from trip No. 1 to 48 at one-third more oz. for their probable product in any given month.

Nacupi Co.—Sold occasionally a few hundred ounces here for present needs after November 1876, when they began to be financially hampered. They finally went into bankruptcy, March 1873, and have been closed up ever since. But the foregoing pretty fairly represents their product.

Hansa Co.—Made little more than shown here; some went by private hands to Bolivar; none sold here. They stopped milling, November 1874, and did not reorganize until October 1877.

Panama Co.—Began milling, August 1876; really began, November 1875; but exploded both boilers following December, and water-works and new boilers not finished until July 1876. They frequently sell all their gold in Caratal; sometimes a part only. Since their failure last March, owing to poor quartz, all sold in Caratal. Full time for them is about 1000 oz. per month.

Potosi Co.—Never sold any gold here; therefore this represents their full product. The blanks are stoppages for breakdowns, repairs, or alterations.

Remington Co.—Only ran 6 months. Quartz good, but vein too small.

Mocupia and New York Co.—This represents their full product. Variations represent fewer hours by breakdowns, &c.

Caratal Co.—This also is full product. Their year's stoppage, 1877, was to pull down old mill and build new 20-stamp mill.

Nueva Hansa.—Just begun; was drowned out by the river.

The aggregate production, as per accompanying table, is 288,678 oz. of fine gold; and if to this is added the number of ounces that are carried by merchants and private conveyances, estimated at about 40,000 oz. more, we have a sum total of 328,678 oz. which, at the round value of $20 (4*l.* 3*s.* 4*d.*) gross per oz., makes $6,573,560 (1,369,491*l.*) produced by the mining region of Venezuelan Guayana in 4 years and 8 months; a surprising result, considering the immense difficulties of every kind that

QUARTZ MILLS IN GUAYANA DISTRICT, THEIR RECORD FROM MAY 1874 TO DECEMBER 1878.

NAME OF MILL AND MINE.	OWNERS.	Stamps.	Drops per minute.	Weight of stamps.	Height of screens above dies.	Drop of stamps.	Quartz crushed per 24 hours.	Average yield of standard gold per ton of 2000 lb.	When the mill first started.	Standard gold produced from May 1874 to December 1878.	Depth of mine on incline.	Dip of vein.	Average width of vein.	Direction or strike of vein.	Average of time mill has run since starting to stoppage or date.	REMARKS.
		No.	No.	lb.	in.	in.	tons.	oz.		oz.			in.			
Buena Ritero	Venezuelan ..	5	35	250	6	6	4	¼ to ½	Nov. 1867	500	Surface	None.	None.	None.	..	Ran about a month only, and failed. Has been moved away.
Nacupi ..	Orinoco Ex. and Mg. Co., Philadelphia	25 50	50 60	450 600	6	12	35 75	1¼ to 2¼	Oct. 1868	39,369	200	60° S.E.	34	N. 20° E.	Nearly full time to 1875; since ½ time	25 stamps to 1877; then 50 till shut down, April 1878. Still idle.
Callao ..	Venezuela & London ..	15 25 40	60	650	6	11	15 50	4 to 8	Dec. 1869	135,822	300	45° W.	30	N. 5° W.	Nearly full time	15 stamps to 1875; then 25 till 1877; then 40 stamps.
Potosi	London ..	20	50	650	3	12	30	2 to 4	Jan. 1870	37,656	250	52° S.	40	N. 80 E.	½ time	Delays for usual breakdowns and alterations.
Mocupia and New York	New York & Venezuela ..	10	65	600	10	8	12	2½ to 5	July 1870	18,592	250	52° S.	48	N. 80 E.	½ time	Now building 20 new stamps. Delays, breakdowns, and scarcity of water.
Caratal.. ..	New York ..	10 20	55	650	10	10	14 30	2½ to 3½	July 1870	19,673	200	45° E.	100	N. 20° W.	Nearly full time	10 stamps to 1878; then 20 stamps. Lost all of 1877. Rebuilding.
Hansa ..	Venezuela & Germany ..	20	60	650	9	9	24	1 to 1½	Oct. 1871	619	69	55° S.	60	N. 80° E.	1/12 time	Failed in 1873 by death of manager, and too much water. Reorganized 1878. Delays—too much water.
Remington ..	New York ..	20	55	600	6	10	30	2 to 3	July 1872	3,567	78	75° E.	18	N. 45° W.	½ time	Failed in August 1877. Still idle. Delays—want of quartz.
Panama	Philadelphia & Venezuela	30	50	650	8	10	35	½ to 1½	Nov. 1875	11,119	200	35° S.	30	N. 50° W.	⅓ time	Partially failed in 1878, from many accidents and unusual breakdowns. Five stamps average work now. Delays other than above, want of wood and water.
Union	Venezuela ..	5	60	550	8	8	8	2½ to 3½	Jan. 1878	About 2,000	50	Mixed	Mixed 18 to 30	Mixed	½ time	Now building 5 more stamps Delays—want of water.
Nueva Providencia	Venezuela ..	20	60	600	10	9	30	⅓ to ½	June 1878	Nothing	80	Mixed	12 to 30	Mixed	..	Ran about a month; then stopped to search for richer quartz and water.
San Luis	Venezuela & France ..	20	60	600	10	9	25	¼ to ½	Aug. 1878	Nothing	100	60° S.	36	N.E. & S.W.	..	Ran about a month; then stopped to search for richer quartz and water.
Eureka.. ..	Venezuela ..	20	Not	yet	built	..	..	..	..	..	60	60° S.	30	N. 60° E.	..	Machinery now erecting.
Concordia ..	Venezuela ..	20	..	..	..	..	..	..	..	..	40	Not	known	..	..	Machinery on the road, to arrive soon.

GENERAL NOTE.—All use quartz, and work their mills nearly alike for free gold (no other yet). Amalgamate in batteries; tables and copper plates; no blankets. As yet, sulphurets are in too small a percentage to save.

the companies have had to contend with in a wild, tropical region, difficult of access, and far removed from civilization and its advantages.

According to the Report of the British Consul at Ciudad Bolivar, for 1880, gold is the chief and almost, it may be said, the only industry of the State, on which both public and private incomes more or less depend. Absorbing, as it does, almost all the labour of the State, by offering superior inducements, it renders every other enterprise entirely hopeless. Gold-mining is the sole pre-occupation of all minds. In this vice-consular district, as an industry, it only dates, it may be said, from 1866, when companies were formed for working this hitherto undeveloped source of wealth. But whether from the enormous expenses which have to be incurred in importing and setting up suitable machinery, the transporting of it to Caratal, a distance of about 150 miles from Port Las Tablas, by bullock-wagons, or the exceptional dearness of labour, provisions, and fuel, which latter has to be procured from the adjacent forests at great outlay, for the working of steam machinery, the fact is that until now only one, the Callao Company, has returned dividends to its shareholders.

A fair average of the yield of the quartz of the different companies is 2½ oz. per ton. A new gold-field, said to be of vast extent and richness, has been recently discovered at a place called Cicapra, about 150 miles from this city, and 50 miles N.E. of Caratal. A good deal of placer-gold has been obtained lately from this locality. According, however, to the opinion of experienced mining engineers, who have visited that district, it is likely to become, if properly developed, amongst the richest of these auriferous regions.

SPECIFICATION OF THE GOLD-MINING COMPANIES ESTABLISHED AT THE DEPARTMENT ROSCIO, STATE OF GUAYANA, 1879.

Names.	Capital.	Stamps.	Observations.
	bolivars.		
Callao	1,288,000	40	In activity.
Potosi	Private	30	,,
Mocupia and New York	1,200,000	20	,,
Caratal Gold	520,000	20	,,
Independiente	500,000	5	,,
Union	975,000	..	,,
Nueva Providencia	700,000	20	Closed.
Nueva Hansa	800,000	20	,,
Concordia	900,000	20	Closed for want of funds.
San Luis	980,000	20	,, ,,
Eureka	540,000	20	,, ,,
Orinoco Exploring	..	40	Bankruptcy Court.
South American	..	30	,,
San Salvador	1,000,000	..	Prospecting works.
San Antonio del Arbolito	600,000	..	,,
Porvenir	1,000,000	..	,,

The *bolivar* is equivalent to 1 *fr.*; 25 *bolivars* = 1*l.*

As the Union Company has got no stamps, it makes use of the mill of the Nueva Providencia.

STATEMENT OF THE MONTHLY REMITTANCES OF THE GOLD-MINING COMPANIES, STATE OF GUAYANA, VENEZUELA, DURING THE YEAR 1879.

Name of Company.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.
Callao.. ..	3,707·14	5,839·31	4,447·17	4,715·12½	1,705·59	1,344·04	1,635·46	2,235·60	3,542·12	3,491	3,367·75	3,831·62	39,861·92½
Potosi.. ..	609·10	1,223	1,134	1,576·90	1,491·70	550·50	919·10	1,200	1,283·10	965	1,335·10	1,290	13,577·50
Mocupia & New York	497·25	1,174·50	965	803·75	992·12½	853·50	870·50	1,108·75	928·18	1,051	1,172·06	1,369·12	11,785·73½
Caratal ..	350·50	664·50	559·25	392·50	481·75	528	764	557·25	846	533·50	368	518·50	6,563·75
Nueva Hansa	..	251·50	79·87	..	..	34	32·25	..	..	..	143	141·19	681·81
Eureka ..	..	..	..	..	..	159·88	117·50	..	..	..	..	..	277·38
Total ..	5,163·99	9,152·81	7,185·29	7,488·27½	4,671·16½	3,469·92	4,338·81	5,101·60	6,599·40	6,040·50	6,385·91	7,150·43	72,748·1

STATEMENT of the gold from the Caratal Mines, State of Guayana, shipped at the Port of Ciudad Bolivar from January 1866 to December 1879.

	Ounces.
1866 ..	15,587
1867 ..	30,142
1868 ..	29,050
1869 ..	33,555·63
1870 ..	35,713·75
1871 ..	25,941
1872 ..	32,747·25
1873 ..	41,649
1874 ..	55,698·04
1875 ..	79,496·69
1876 ..	86,529·66
1877 ..	100,988·69
1878 ..	95,204·79
1879 ..	107,722·76
Total ..	770,026·26

This important and rich gold-field has been ably and minutely described by Dr. Clement Le Neve Foster, from whose valuable account the following facts are taken.

The Caratal gold-field is situated about 160 miles in a straight line east-south-east of Ciudad Bolivar, or Angostura, the capital of the state of Guayana, in Venezuela. It lies 100 miles south of the river Orinoco, some 75 miles up from the principal mouth.

The country between Ciudad Bolivar and Pastora consists almost entirely of gneiss, with some mica-schist, and hornblende-schist, and a little granite. All three varieties are seen at Ciudad Bolivar itself. From here to the Caroni is a gently undulating savannah, showing outcrops of gneiss as far as the neighbourhood of the Arasiama ridge, which is formed of itabirite (see p. 220). About Arasiama and on both sides of the Caroni near Guri, the strike of the gneiss is, roughly speaking, east and west.

Beyond Charapo is some hornblende-schist, striking E. 15° N., in land which forms the watershed between the basin of the Orinoco and that of the Essequibo. Where the road crosses it, the watershed is not more than about 1100 ft. above sea-level. Further east, at Limones, is granite; but the greater part of the country consists of gneiss, which now gets a strike of N. 18° W. to N. 15° E. Both east and west of the Oranato, Dr. Foster found hornblendic schist, striking N. 10° E., N. 45° W. And in crossing the Guatapolo, he noticed a dyke of porphyrite, resembling some of the Cornish elvans, and remarkable for the well-crystallized quartz which it contains.

Before arriving at Pastora, the series of schists and slaty rocks, which continue into the Caratal district, make their appearance; near Pastora are siliceous schists striking N. 45° W., N. 60° W., N. 70° W.; and at Caratal itself these rocks are often a fine-grained clay-slate, like some of the Cornish "killas." At other times, the rock is much coarser; and a talcose variety frequently occurs. As a rule, these slaty rocks are much decomposed. The decomposed schist forms the "bed-rock" in many of the alluvial diggings, and is known to the miners as *cascajo*. Besides these slaty rocks, there are large outcrops of a felstone, either intrusive or interbedded; this is the "blue-stone" of Dr. Stevens, a compact grey, bluish-grey, or greenish-grey rock, often containing small crystals of iron-pyrites, the "mica" of the miners. The schistose rocks have, roughly speaking, an east and west strike, with a varying dip.

It was only on the north side of the Yuruari, near the Tupuquen Ford and north of Callao, that Dr. Foster noticed outcrops of a rock which he calls "gabbro," on the authority of David Forbes, F.R.S. To the north of the mining district—in fact, in the country about Upata, gneiss, mica-schist, hornblende-schist, and granite occur. It will thus be seen that to the west and north the gold-bearing slates are surrounded by gneiss and other metamorphic rocks. No fossils have as yet been found, though carefully searched for by Dr. Plassard ever since he discovered the gold-fields. The age of the rocks is consequently unknown.

The gold-deposits of the Caratal district may be classed under 4 heads:—(1) Lodes, veins, "reefs," "ledges," or *filones*; (2) alluvial or "placer" diggings, or *greda*; (3) red earth, or *tierra de flor*; (4) gravel and sand of river-beds.

1. *Lodes.*—About a dozen lodes have been discovered, and worked on. It is impossible to give any general direction of the strike and dip of these lodes; but it may be observed, that several well-marked and rich lodes run east and west, while others, equally productive, have strikes approaching to north and south. As the lodes are few in number, a short description of each will furnish the best idea of their general nature.

The Callao lode lies about 1¾ mile N.N.W. of Nueva Providencia. It is a north and south lode dipping west, and is 1 to 2 ft. thick in many places; it consists mainly of quartz, with a little iron-pyrites and brown oxide of iron, and a few blackish streaks, due, perhaps, to chlorite. The gold in this lode is very coarse, and specimens of pure white quartz and native gold, without a particle of oxide of iron, are often found.

The surrounding rock or "country" is felstone, with a little iron-pyrites. The miners say that the presence of iron-pyrites is a favourable sign for the productiveness of the lode. The Callao lode has been worked along the strike for a distance of about 200 yd., and it is said to die out southwards. The deepest workings in the Caratal district are upon this lode; but they only reach down 36 yd., further progress being prevented by water, and the want of pumping machinery. Very large quantities of gold have been obtained from Callao.

The Corinna lode is situated further eastward, on the bank of the Yuruari. The lode is 4 ft. wide in places, and dips west. It consists mainly of quartz, with brown oxide of iron, mammillated pyrolusite, thin streaks of a blackish mineral, and visible gold. This lode has been worked to a depth of about 12 yd., and has been profitable.

In the neighbourhood of the Corinna, the American Company has made openings upon other lodes and branches. Some of the quartz shows visible gold, the rest does not, but all is auriferous; on an average, Dr. Foster was told that the quartz from these openings gives about 1½ oz. of gold to the ton. The "country" of these lodes and of the Corinna consists of decomposed schist. On the hill south-east of Nueva Providencia are numerous abandoned *barrancos* or pits sunk to work the Tigre lode. Its strike is N. 30° E., and it is said to be about 1 ft. wide, and very rich. The country is a hard, dark-greenish rock.

In Nueva Providencia, numerous blocks of loose quartz containing gold are lying about in one part of the town, probably derived from a lode which crops out here; and the Prefect of the Department of the Yuruari has been working a lode in his garden just east of the town. In the San Felipe property, to the south of the town, several lodes are said to have been discovered.

The Peru lode, situated near the source of a branch of the Mocupia brook, runs E. 5° N., and dips S. at 60°. It is 2 ft. wide, and consists of quartz, with brown oxide of iron, the usual blackish streaks, talc, and visible gold.

In another little neighbouring valley are the Potosi workings. In one of the adits driven into the hillside are two east and west lodes, dipping 55° in opposite directions, the level being driven just below the intersection. The stuff is very similar to that of "Peru," and there is no difficulty in finding visible gold.

The Chili lode lies about ¼ mile south of Potosi, and, after Callao, is at present the most important in the Caratal district. The Chili main lode runs about E. 10° N. to E. 15° N., and dips S. at 45° to 60°. It varies in width from 2 to 6 ft. It consists mainly of quartz, with brown oxide of iron, the blackish streaks, talc, a white, earthy mineral like kaolin, and visible gold. In many pieces of stuff from this lode are cubical cavities lined with gold as if they had been plated, or containing leafy gold; sometimes also the cavity is filled with brown oxide of iron, in which specks of gold are visible. The cavities seem to be due to the decomposition of iron-pyrites, which originally filled them. The coarse gold which is found at Callao does not occur at "Chili." To the west, the Chili lode splits up into at least three branches.

The Chili main lode has been worked to a depth of about 30 yd. The "country" is decomposed talcose clay-slate. In several of the shafts which have been made on this lode, the *porfiro* or *porfido* of the miners occurs. This so-called "porphyry," also known at Chili as *quartzo morado* and *piedra morada*, is a reddish, pink, or brown ferruginous hornstone, sometimes becoming jasper. It now and then contains crystals of iron-pyrites, or cavities left by their decomposition. At Chili, it forms a sort of lode parallel to the white quartz lode, from which it is separated by a few inches of *cascajo*. The "Chili" miners told Dr. Foster that they occasionally found visible gold in it, but too little to pay them to work it. A similar rock (*porfiro*) is found all over the Caratal district, and is regarded by the miners as a favourable indication for gold.

A little work has been done on a lode called San Antonio, a short distance from "Chili." Two *barrancos*, very close to one another, have been sunk upon it; and they show a quartz lode 2 ft. thick, which strikes S. 20° E. to S. 45° E., and dips sharply to the west. The surrounding rock is *cascajo*. The lode consists of quartz, with black streaks, iron-pyrites, brown oxide of iron, and very fine gold.

Lying in the basin of the Yguana, like Chili and San Antonio, are the Panama workings. Much work has been done here upon loose blocks of quartz which strew the hillside, and a small opening has been made on the top of the hill, upon an east and west lode. This lode is 3 ft. wide in places, and dips south. On the opposite side of the valley, a flattish lode 2 to 6 ft. thick has furnished a good deal of quartz. Quartz has also been found and worked at the Lagunta, near Panama, and at the Independiente, between Panama and Nueva Providencia.

2. *Alluvial or "placer" diggings.*—Excepting a few places on the banks of the Yuruari, the working of auriferous alluvions has at present been confined to the valley of the Mocupia, and its various tributaries, such as the *quebradas* or valleys known as the Tigre, Peru, Aguinaldo, &c.

On leaving Nueva Providencia by any of the paths to the west, the traveller comes upon pit after pit, 6 to 10 yd. deep; and although this ground was worked as early as 1857 and 1858, it can be pretty well seen what the diggings were like.

The following is the succession of the beds:—

1. Soil.
2. Red clay, showing no signs of stratification.

3. Soft clayey *moco de hierro.*

4. Hard *moco de hierro*, brown iron ore, with pieces of quartz in it, and a little clay.

5. Blocks of vein-quartz, often auriferous.

6. *Greda*, or pay-dirt, a yellow ferruginous clay, containing nuggets and small grains of gold.

7. *Cascajo*, decomposed schist, forming the bed-rock.

About ½ mile from the town, on the road to Tupuquen, are the Planada diggings, said to have been worked with much profit in 1857. The section of one of the Planada pits is as follows:—

1. Soil.
2. Clayey gravel.
3. Blocks of quartz.
4. *Greda*, or pay-dirt.
5. *Cascajo*, or bed-rock.

In a neighbouring pit, Dr. Foster saw about 6 ft. of clay, and then 6 ft. of gravel, the bottom being filled with rubbish. The pebbles found in the gravel are mainly composed of the greenish-grey felstone, known as *piedra negra*; subangular and rounded pieces of ferruginous hornstone are also common. Higher up the valleys the placer-diggings are shallower.

3. *Tierra de Flor and Moco de Hierro.*—In many places in the Caratal district, just below the soil, at a depth of 18 in. to 3 ft., is a layer of red earth, often containing pieces of auriferous vein-quartz, pieces of *moco de hierro*, and grains of pysolitic brown hematite, the "granson" of the miners. When washed, this *tierra de flor*, or "surface earth," as it is called, furnishes, in addition, decomposed crystals of iron-pyrites, a black magnetic iron-sand called *arenilla*, and often nuggets of gold. The manner in which the gold occurs appears to be very irregular; the miner may wash several *bateas* of earth, and find no gold, or only the *color de oro* (i. e. merely a few fine grains of gold), and then get several nuggets in the next lot. The largest nugget yet found in the Caratal district was obtained from the *tierra de flor*, close to Nueva Providencia; it weighed 15 lb.

In the diggings at the south-south-west corner of the town, Dr. Foster saw *tierra de flor* lying above alluvial ground.

The following is the succession:—

1. Soil.
2. *Tierra de flor*, red earth, with loose stones of quartz.
3. Ferruginous clay.
4. *Greda*, or pay-dirt, yellowish clay, with blocks of quartz.
5. *Cascajo*, or bed-rock, decomposed schist.

From the manner in which this term *tierra de flor* occurred, Dr. Foster at once concluded that, geologically speaking, it was a "rainwash";

but it was only after talking the matter over very frequently that he and Dr. Plassard arrived at the conclusion that the *tierra de flor* is nothing more nor less than decomposed *moco de hierra* washed down the hillsides.

The name *moco de hierro* is given to a highly ferruginous rock, which assumes the various forms of:—

a. Ferruginous conglomerate.
b. Ferruginous grit.
c. Ferruginous breccia.
d. Pisolitic brown iron ore.

It always consists mainly of limonite and earthy red hematite, with pebbles or angular and subangular fragments of quartz, schist, and felstone. When it takes the form of pisolitic brown iron ore, it consists of a number of globular concretions of limonite. This *moco* is found in loose blocks on the surface, and often forms plateaux, sometimes more than 100 (or even 200) acres in extent. The edge of the plateaux is generally marked by a bold rocky escarpment. Here it may be seen that the *moco* is 6, 8 or even 10 ft. thick at the least; and the same thing may be observed where a stream has cut its way down through a *moco* plateau.

In searching for quartz lodes, Dr. Foster came to the conclusion that the *moco de hierro* affords no evidence of lodes in the immediate vicinity; for his observations led him to infer that it is probably of alluvial origin. He supposes that the ferruginous matter of which it consists so largely is derived from iron-pyrites, which was contained in the alluvial deposit, partly in the form of loose pieces, and partly enclosed in fragments of rock. Some may also have been derived from chalybeate waters coming from other sources than the alluvium itself. In some cases, the *moco* is of undoubted alluvial origin; and the miners, finding that where they met with a bed of *moco* they usually had a good pay-dirt, or *greda*, came to the conclusion that the *moco* was a good indication of gold-deposits of all sorts. Dr. Foster adds that the alluvial *moco* lying above the pay-dirt has occasionally furnished nuggets covered with a black coating of oxide of iron, like some that are found in the *tierra de flor*.

From all this, it will be seen that there is nothing in the mode of occurrence or mineral contents of the *tierra de flor* to militate against the hypothesis that it is neither more nor less than *moco* decomposed in place, or decomposed *moco* washed down the hillsides.

Should all the *moco* be of alluvial origin, we may expect a pay-dirt below it in the higher plateaux, just as we find one in the more recent deposits; and it is possible that the nuggets in the red dirt are mainly derived from a pay-dirt underlying the *moco*, and not from the *moco* itself.

Some assays of *moco* that Dr. Foster made at Caratal gave gold; some that have been made since, gave either no gold or merely traces.

There are therefore two points which remain to be settled with regard to the *moco*:—

(1) Whether it often contains gold enough to make it a workable deposit.

(2) Whether all *moco* is really a deposit like the *moco* of the placer-diggings near the town, or, in other words, whether it overlies a pay-dirt or deposit of alluvial gold.

4. *Recent Stream-beds.*—When the dry season commences, the rivers and streams sink rapidly; many dry up entirely; others still have a few waterholes left; while the Yuruari always flows a little, except in seasons of most extraordinary drought. In any case, banks of sand and gravel are left high and dry, or partially so. On digging through them, a gold-bearing bed is often met with, which furnishes nuggets and small grains of gold on washing. The amount of work which goes on with these deposits at the present time (1869) is but small, though at first they were the only ones that were known.

The whole of the present (1869) workings are comprised within a circle of 3½ miles radius, with Nueva Providencia as its centre; but it must not for a moment be imagined that this is the whole of the auriferous region. Two American gentlemen, Davis and Austen, found gold on the river Paragua; and just before leaving, Dr. Foster heard of the discovery of a lode of gold-quartz in the hills to the south of Pastora. A little gold has been found at Upata. Dr. Plassard also told him that a lode of auriferous quartz traverses the bed of the Yuruari at Cura; and the same was reported by Señor Carlos Siegert. It is further known that gold has been found, and even worked, on the banks of the Cuyuni, in British Guiana (see p. 245). All these facts tend to prove that the auriferous rocks are spread over a very wide area indeed.

The old Spaniards, by following the rivers and searching the ravines, discovered quantities of gold in the rivers Tesorero, Santa Crux, and Guaratarro, which abounded in large nuggets; the remains of their washings can be seen at the present day.

Humboldt, speaking of the rivers which descend N.E. towards the coast of Puerto Cabello and La Punta de Hicacos, says the most remarkable are those of Tocuyo, Aroa, and Yaracuy. In the ravines nearer the sea, the Indians have their gold-washings. Grains of gold-ore are found in all the mountainous lands between the river Yaracuy, the town of San Felipe, Nirgua, and Barquismeto, particularly in the Rio de Santa Crux, in which the Indian gold-gatherers have sometimes found lumps of the value of 4 or 5 *piastres* (say 12*s.* to 15*s.*). The gold-deposit of Tesorero is about 1½ league from Guaratarro. The Spaniards had several washings here, and the Creoles say quantities of gold in large nuggets were discovered.

Capt. Prince writes (Min. Jl., xlviii. 999) that after spending a fortnight in the Tesorero and Guaratarro districts, inspecting the rivers, valleys, and ravines in the vicinity of Tesorero, which is situated about 3 miles N.N.E. of the Guaratarro, he discovered in all the ravines particles of gold, and this with only a slight surface washing in *tolumas* and common dinner-plates, particularly in the dry bed of a flood torrent called the Quebrada de Tucana, situated 1 mile S.S.E. of the hamlet of Tesorero; in short, for many miles, vast ferruginous alluvial deposits, auriferous in all parts.

The placer-gold of Venezuela is said to contain about 8 per cent. of silver.

Callao mine.—More detailed information regarding the great Callao mine is contained in two recent reports by Hamilton Smith and Charles Oxland respectively, which were very obligingly placed at the disposal of the author by the Hamburg company owning the property, and from which the following observations are derived.

Hamilton Smith's report [abridged]:—

"The country-rock in the district is a compact greenstone or diorite (?) whose character does not materially change for a distance of several kilomètres. The principal lodes are of quartz, more or less sugary in quality, and are doubtless true fissure-veins, having the greenstone for both hanging- and foot-walls, with but a small parting or gangue—sometimes none—separating the quartz from the country-rock. In some places the greenstone is considerably mixed with the quartz, and occasionally carries gold to some little distance from the quartz.

"The veins have generally a flat dip or inclination, varying from 60° to 35° from the horizon; their strike (direction of lode on horizontal plane) is in different directions, being N. and S. at Callao, E. and W. at the Chili and Panama, and N.W. and S.E. at the Orinoco.

"Gold is carried by the quartz indifferently through the vein. When found in the pure white quartz, it is exceedingly bright and perfectly 'free' (readily amalgamates); where found in bluish streaks, it is darker and less pure; and when the vein is mixed with country-rock, the gold is often in close connection with pyrites.

"The greatest vertical depth thus far attained has been 130 mètres (65 fathoms) at the Callao mine, and nearly 91 mètres (45 fathoms) at the Chili lode. To the eye the character of the gold does not appear to change as greater depths are reached. At the north-west corner of Callao No. 4 workings, at a vertical depth of 116 mètres (58 fathoms), by far the greater part of the gold carried by the vein is in the pure white quartz. In the Mocupia mine, on the deepest workings of the Chili lode, the same condition exists. At the present time, from the Callao mill, the amalgam yields nearly 47 per cent. of retorted gold, of a fineness of 915 to 925, which also shows that in the Callao ore the gold still continues coarse and free. In these deeper workings, as is the case nearer the surface, where the vein is mixed with country-rock, more sulphurets are present, and the ore is consequently more refractory and difficult to properly reduce.

"In the Callao mine, which was the one most carefully studied, this admixture of the country-rock with the vein seems to be chiefly on the northern and southern limits of the 'pay-shoot' of ore, and to indicate approaching weakness or pinching of the vein.

"The ore in the district can therefore be assumed to be 'free,' that is to say, the gold can in a great measure be obtained by the mill process as carried on in the ordinary and simple gold-quartz reduction-works of California and other portions of the United States.

"The reduction machinery in use in the district is of a very primitive nature, consisting simply of stamp-mills, with amalgamation in the batteries and on copper plates, but none of the ordinary auxiliary gold-saving appliances.

"The placer-gold is extracted by washing with the *batea* or wooden bowl, the 'rocker' and 'long-tom' used in California and Australia, not having been introduced. Owing to the gentle slope of the Yuruari and the rich ravines and flats, it was and still is impracticable to wash these placers by ground-sluices, and cheaper hydraulic methods, such as have been so largely used in the precipitous gold-regions of other parts of the world.

"The yield of the Callao mine in 1879 was as follows :—

January..	885	tons crushed yielding	4·24	oz. per ton.
February	1023	,, ,,	5·78	,, ,,
March ..	866	,, ,,	5·19	,, ,,
April ..	872	,, ,,	5·47	,, ,,
Total	3646	tons, average yield	5·20	,, ,,

"The Callao reduction-works consist of a good stamp-mill, stamps weighing about 650 lb. (English); drop, 9 in.; 60 drops a minute; each stamp crushing about 1½ ton in 24 hours; screens rather coarse; amalgamation in batteries and on copper plates. Some of the heavier tailings are treated in revolving iron barrels, which in 1880 yielded nearly 2 per cent. of the gross product. Samples of the tailings running to waste, from batteries 9, 10, 11 and 12 (20 stamps), gave the following results :—

20 large hourly samples	Nos. 9 and 10	assay	60 oz. gold, say 900 fine.
20 ,, ,, ,,	11 ,, 12	,,	82 ,, ,, ,, ,,
42 ,, ,, ,,	9, 10, 11, 12	,,	99 ,, ,, ,, ,,
	Mean		81 oz. gold, say 900 fine.

"Such loss from ore of this class, yielding 2 oz. per ton, is very large; indeed one-half as much would be excessive. It is probable that the loss from these 4 batteries sampled is greater than from the 8 batteries."

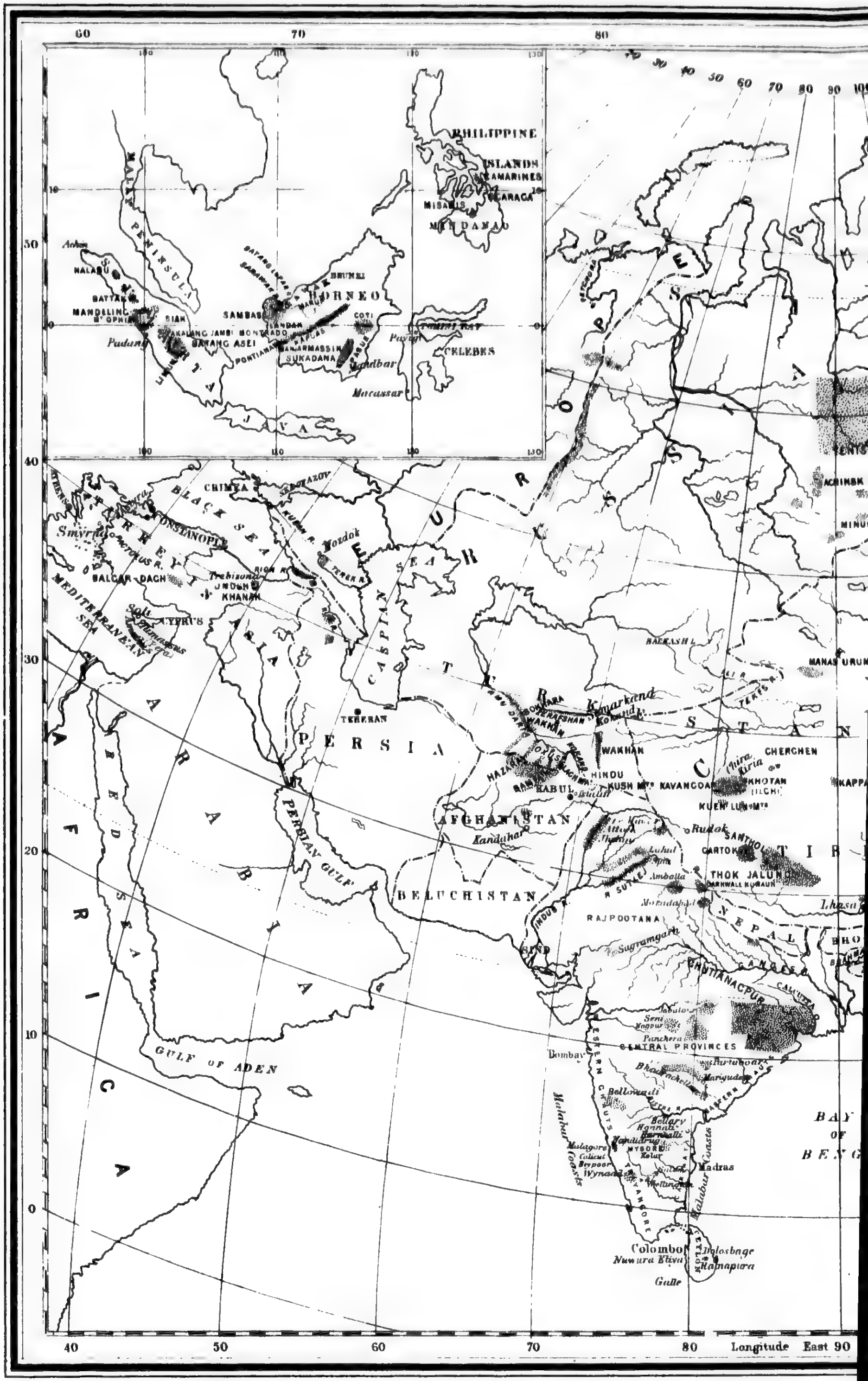
Charles Oxland's report [abridged] :—

"The quartz is compact, and carries the gold coarse and free. But little pyrites is found, equal to about ½ to ¾ per cent. of the ore, and this appears in streaks that would be likely to lead an expert to believe that it is greatly on the increase; but after the appearance of the streaks, the lode again returns to its normal character, carrying little or no pyrites.

"In the bottom of the workings the lode has increased in size, and the quality of the quartz is excellent. Some of it is exceptionally rich, and will probably yield about 5 oz. of gold to the ton.

"The mine has yielded, from the year 1871 to March 1881, the amount of 322,000 oz. of gold (standard), resulting from an estimated amount of 92,325 tons of ore. The number of tons is probably considerably less than this, as no weighing-machine has been used, and consequently the weight had to be estimated. The yield for 7 months in 1881 was as follows :—

	Oz. of gold.		Oz. of gold.
April	6726	August	5473
May	6624	September	6029
June	6909	October	7314"
July	4750		


PHILIPPINE ISLANDS
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CARAGA
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MINDANAO
MALAY PENINSULA
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Padang
SUMATRA
KAKALANG JAMBI
BATANG ASEI
BORNEO
BRUNEI
SAMBAS
LANDAK
MONTRADO
PONTIANAK
BANJARMASSIN
SUKADANA
COTI
Mandbar
Macassar
CELEBES
JAVA
CRIMEA
AZOV
BLACK SEA
Smyrna
CONSTANTINOPLE
TURKEY
BALCAR-DACH
Trebizond
KHANAH
Mozdok
CYPRUS
MEDITERRANEAN SEA
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PERSIA
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RED SEA
GULF OF ADEN
AFRICA
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Samarkand
Kokand
BOKHARA
ZERAFSHAN
WAKHAN
HAZARA
KABUL
HINDU KUSH Mts
KAVANGOAR
CHERCHEN
Chira
Kiria
KHOTAN (ILCHI)
KUEN LUN Mts
AFGHANISTAN
Kandahar
BELUCHISTAN
Attock
Lahul
Spiti
Amballa
R. SUTLEJ
INDUS R.
Rudok
SANTHOL
CARTOK
THOK JALUNG
GARHWALL KUMAUN
Moradabad
Lhasa
TIBET
NEPAL
RAJPOOTANA
SIND
Sugramgarh
CHUTIANACPUR
GANGES R.
CALCUTTA
Jabalpur
Seni
Nagpur
Panchera
CENTRAL PROVINCES
Bombay
Partabpur
Bhadrachellam
Marigudem
Bellowadi
WESTERN GHAUTS
EASTERN GHAUTS
Malabar Coast
Bellary
Honnali
Harnhalli
Nandidrug
MYSORE
Kolar
Calicut
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TRAVANCORE
Madras
Coromandel Coast
Colombo
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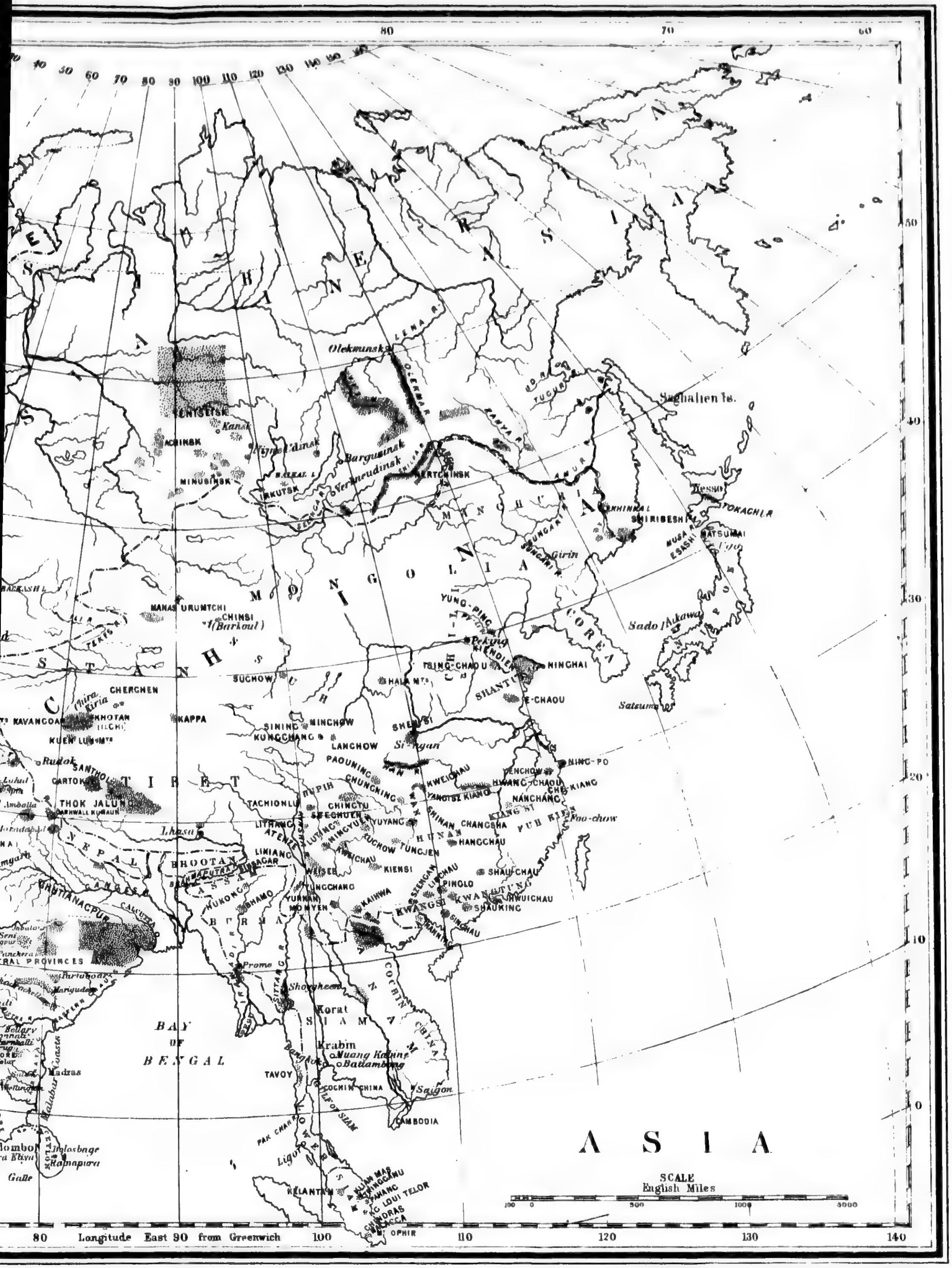

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ASIA.

AFGHANISTAN.—Col. Yule (1875) says that some small quantity of gold is taken from the streams in Laghman and the adjoining district; and he alludes to a stream in Wakhan, called Zerzumen by Wood, which he thinks may be Zarzamin ("gold ground"). Wood (1841) says that "the Kokcha, like every other tributary of the Oxus, is fertile in gold." Hamilton remarks that gold is said to be found in some of the streams that flow from the Hindu Kush mountains. Vigne (1840) states that the sand of the Kirman is washed for gold. Bellew (1874) gives the following account of a visit to the gold-mine at the foot of the hills lying north of the city of Kandahar. The mine is situated on the S. side of and half-way up in a small creek, running N.E. into an angle formed by a spur projecting on to the Kandahar plain from the Baba Wali range. The hills are of a very hard and compact blue limestone; but the surface of the creek and the adjoining plain is a coarse gravel, containing fragments of greenstone, hornblende, quartz, and mica-schist. The mine is close to the ridge of blue limestone. It is a wide excavation straight down into the soil, and in a soft easily-worked rock. Bellew examined several of the stones, and found them to consist of particles of greensand, hornblende, felspar, quartz, and mica, bound together in a gritty ferruginous clay. The formation appears to be one of decomposed syenite, and is sufficiently compact to require blasting in the excavation. The process is very rough, and simply this:—a vein of quartz, 3 or 4 to only ½ in. or less thick, is exposed in the rock, either by the use of the pickaxe, or by the aid of gunpowder. The workmen then examine the vein with the naked eye, and if any particles of gold are detected, they are removed with the surrounding portions of matrix, by means of a chisel and hammer. An immense number of quartz veins traverse the rock in all directions, and in several of them compressed plates of gold are visible, *in situ*. In some instances the metal was seen by Bellew in thick, lumpy masses, nearly the size of an almond. There must be an immense amount of waste in this rough process, and no doubt the heaps of excavated rock lying about the mouth of the pit would yield to the experienced miner a very profitable return. The mine has now been worked nearly 12 years, but with several intermissions. For the first 2 or 3 years, it is said to have yielded very abundantly. It is now farmed by a contractor, at an annual rental of 500*l*. As the surface gravel of the plain, N. of the city, is of the same character as that of the creek in which the mine is situated, it may be reasonable to suppose that the gold-yielding stratum extends under the alluvium of the plain.

According to Griesbach (1881), the gold occurs here in quartz veins (reefs) which traverse the zone of contact between the hippuritic limestone and the extensive trap outbursts, and, as far as he could ascertain, are confined to the lower beds of the Cretaceous limestone. The quartz veins vary in thickness from the width of a pencil-line to many ft., and most of them strike N.E. and S.W. The contact rock is calcareous, and contains a green mineral, disseminated through the mass. F. R. Mallet has examined the rock, and found that the portion soluble in dilute hydrochloric acid consists mainly of lime and magnesia, with some iron. The insoluble part is chiefly silica and alumina, with some iron and magnesia. There is also a trifling amount of copper, and scarcely more than a trace of nickel. The rock appears to be an extremely impure (arenaceous and argillaceous) ferruginous magnesian limestone. The green spots evidently owe their colour to the copper and in part perhaps to the nickel. Such is the matrix of the auriferous quartz reefs.

The native miners continued sinking their productive shaft, until the sides of it at last gave way, burying those who were working below. Since then, nothing has been done. The shaft is now 60 to 80 ft. deep, and about as wide, filled with rubbish from the sides. The auriferous vein, which was yielding gold in good quantities at the time the mine fell in, is mostly covered with blocks from above. The portion exposed is only about 2 in. thick, but Griesbach was told it thickened lower down to about 2 ft. or more, and some of the nuggets of gold obtained were of the size of a man's fist; all the larger nuggets were extracted by hand, and only the rest of the quartz crushed and amalgamated. He proposed to the late Wali of Kandahar to sink another shaft about 100 yd. S. of the present position, to strike the same or other auriferous veins; but his advice could not be carried into effect, owing to the outbreak of hostilities shortly after.

It is highly probable that gold will be found all along the line where Griesbach found the trappoid beds more or less altered by the younger traps, and traversed by quartz reefs in profusion. This line extends from the gold-mine to the S.W. towards Kokaran, including the Murghan Hill. Gold is also found and worked in some fashion in the Hazara country, and in various streams of Northern Afghanistan.

Comparing Southern Afghanistan with the countries lying W. and N.W. of it, Griesbach notices the vast extent of Cretaceous (hippuritic) limestone connecting them. The features of this formation are very remarkable, and it retains its character uniformly, more or less, over the entire area. In the Hungarian Banat, it is accompanied by a syenitic granite, which Cotta named Banatite; and the contact zone, which is in those places mostly converted into a crystalline rock, yields various ores, amongst them gold. The gold localities in the Banat also yield minerals of cobalt and nickel, and in some places (Oravicza) they are the leading minerals of the auriferous area. So in Afghanistan, the gold-bearing rock occurs near the junction of the Cretaceous group and the igneous zone, and minerals of both cobalt and nickel occur in traces all over the rock.

According to Captain Hutton, gold, which is called *pillah* used to be imported into Kabul from Bokhara, where it was found in the river Amur; the best qualities sold for Rs. 17 to 18 (34*s.* to 36*s.*) per *tola* (180 gr.), and an inferior kind for Rs. 10 (20*s.*). Dr. Balfour states that gold is found with lapis-lazuli at Haladat, near Bamian (34° 52′ 30″ N., 67° 45′ 30″ E.); also at Istalif (34° 52′ 50″ N., 69° E.), in the district of Koh-i-daman; also in the sands of the Kabul river.

ANAM, CAMBODIA, COCHIN CHINA, AND SIAM.—The geography of these four countries is so little known, and their respective boundaries are so ill-defined, that it is impossible to deal with them otherwise than collectively.

According to Richard (1778), the rivers of Tonquin "bring down gold in their sand. Some are employed in finding it in a kind of ditches, into which they purposely turn the course of the water, and find gold at the depth of 5 or 6 ft. in the sands. They find still more in the clefts of the rocks, and the streams of springs which issue from them, which indicates mines not yet discovered: there are even districts where gold should be very plentiful, since they there breed ducks, merely for the profit of the gold they extract from their excrements. There are, besides, mines that are open, but which are only worked by the Chinese."

According to Sir John Bowring (1857), gold is found in many parts of Siam. The most productive locality is Bang Taphan, in the province of Xumphon, at the foot of the high mountains called the Three Hundred Peaks. Grain-gold and nuggets are collected. The soil containing the gold is crushed and washed in wooden bowls, and, by agitation, the metal is separated from the mass. The gold-mine is guarded by orders from the king, and worked only under special authority. Private individuals are allowed to collect gold, on condition of their paying for the privilege a certain amount per day; but the climate is most unhealthy, and the yellow fever carries off in less than a month the greatest part of the adventurers.

John Campbell, formerly a Californian miner, went gold-mining in Siam in 1856, at Matabong, 35 miles by land from Bangkok. He describes the district as consisting of ravines in an elevated basin, oval in shape, 30 miles long and 18 miles wide, surrounded by craggy walls of rock, the whole covered with dense jungle. The richness of the Matabong district he considers as beyond question; but he complains greatly of the jungle fever, the tropical rains, &c.

Mouhot (1864) has many references to the gold-mines of Cambodia. On arrival at Muang-Kabine (80 miles E. of Bangkok), he found great excitement prevailing, on account of a recent discovery of gold-mines, which had attracted to the place a number of Laotians, Chinese, and Siamese. The mines of Battambong (190 miles E. of Bangkok), being less rich, are not so much frequented. The tribute of the province of Korat, Laos, consists of gold or silver, and in several districts amounts to 8 *ticals* (nearly 4 oz.) a head. Lenye is the district of Siam richest in minerals. In several localities Mouhot discovered auriferous sand, but only in small quantity. In some of the villages the inhabitants employ their leisure time in searching for gold, but they told him that they hardly gained by this work sufficient to pay for the rice they ate. There are also many other mines rich in gold in the chains to the east and west of Cambodia. Unluckily, most of these mountains are frightfully unhealthy, and none but those who have lived there from infancy can remain long among them with impunity.

Kennedy (1867) says that gold-mines were discovered some few years back in the immediate vicinity of Krabin (14° N., 102° E.). They are the exclusive property of the Chao Phya Umerat of Bangkok, who every year despatches an officer to superintend the works, and collect the duty from those who resort there. The gold is obtained by washing. After the discovery of these mines, one or two parties of Europeans proceeded thither from Bangkok; but the business is so trying, and the locality so fatal, that few of the adventurers lived to return, and the practice has consequently been discontinued. It is only in the dry season that the diggings can be worked, and a duty of 1 *fuang* (3⅜*d.*) for every *fuang's* weight of gold extracted, is collected from the miners, among whom Chinese, Siamese, Cambodians, and natives from all the neighbouring races are to be found.

A writer in the *Mining Journal* (xli. 187, 203; 1871), speaking of the territory of Ligor, and of Quedah and the Pak-Chan river, says that, along with the stream tin, gold is often found in considerable quantities, and frequently in pieces as large as green peas. That the rocks contain gold, in payable quantities, he considers past all doubt.

ARABIA.—Of Arabia, it is stated by Strabo (B. xvi. c. 4, § 18; Bohn's Library, iii. 205–6), that "a river flows through their country, which brings down gold-dust; but they are ignorant how to make any use of it. They are called Debæ [the Debæ occupied Sockia: the river which flows through the country is called Boetius by Ptolemy]. Near these people is a nation more civilized, who inhabit a district with a more temperate climate; for it is well watered, and has frequent showers. Fossil gold is found there, not in the form of dust, but in lumps, which do not require much purification. The least pieces are of the size of a nut, the middle size of a medlar, the largest of a walnut. These are pierced and arranged alternately with transparent stones strung on threads, and formed into collars. They are worn round the neck and wrist. They sell their gold to their neighbours at a cheap rate." Pliny (iv. 32) speaks of the *littus Hammæum* in connection with gold, and Capt. Burton would identify it with the modern Hazramaut. Yet Niebuhr declared that "the precious metals are not found or known to exist in Arabia, which has no mines either of gold or silver." And Palgrave (Ency. Brit.) similarly declares that "in mineral products of a valuable description, Arabia is singularly poor, so much so as to suggest that the Arabian gold and jewels of classical writers must have been brought from Yemen as from a mart or depôt, not a place of production. Now-a-days, of gold-mines and precious stones, not a trace can be found."

In contradiction of all this unfavourable testimony, Capt. Burton (1878 and 1879) announced as the result of his two expeditions on behalf of the Khedive, the discovery of great treasures, and of remains of the seven ancient Midianitic cities, which were built on the sites of the gold-mines once worked by the Copts, the Persians, and the Romans. But evidence of the existence of gold in Midian, in considerable and remunerative quantities, is still lacking. In his journey to Medina, Burton ascertained that gold was found near Muwaylah.

ASSAM.—According to Ball, Assam has long been famous for the production of gold, and many authorities have stated that all its rivers contain auriferous sands, some, however, limiting this general statement to those which rise in the hills to the north. Putting aside all exaggeration, it would seem that there are few, if any, named streams in the districts of Darrang, Lakhimpur, and Sibsagar, which do not yield gold; while in 8 other districts included in the Chief Commissionership of Assam, viz. Goalpara, Kamrup, Nowgong; Garo, Jaintia, and Naga Hills; Cachar and Sylhet, there is no gold, so far as our sources of information go. That it is wholly absent in all is not likely; but it is not and does not appear ever to have been sought for successfully in any of them.

The most interesting early account of the production of gold in Upper Assam is by a Hindu named Muniram, the Revenue Serishtadar of Bar Bandari, whose paper on the subject Captain Jenkins forwarded in the year 1838 to the Coal Committee. Here it is said that before the British took possession of the country, the Sonwals paid a yearly tribute of 4000 *tolas* (1500 oz.) of gold, or in value, at Rs. 16 a *tola*, Rs. 64,000 (6400*l.*). While the Government had possession of Upper Assam, 400 Sonwals paid a tax; and at the time of writing (i.e. 1838), the Raja had levied a tax on 150 or 160 *jotes* (i.e. parties of 4 individuals), of these Sonwal paiks. Colonel Hannay estimates that, in the northern district of Sadiya alone, including Lakhimpur, there were 10,000 of these

Sonwals who had to pay at least 4 *annas* weight, or Rs. 4 (8*s.*) worth of gold each; the total amount would be Rs. 40,000 (4000*l.*), and since much was probably paid by the Sonwals south of the Brahmaputra, the total revenue may have been 8000*l.* to 10,000*l.*; the total out-turn did not greatly exceed this, since gold-washing was a service performed by those who held land for their subsistence.

There appears to be no foundation whatever, says Ball, for the statement, first made apparently by Jacob, that the yield of gold in Assam amounted to 30,000 oz. Recently (1881) Hyde Clarke stated that the yield had formerly been 40,000 oz, i.e. the equivalent of 140,000*l.* at the very least. Ball suggests that the rupees of the above statement have been mistaken by some one for oz., and that thus the error arose.

Muniram states that, besides the above-mentioned tax, the Sonwals of Upper Assam, in the time of Raja Rajeswar Singh, used to present 6000 to 7000 *tolas* (2250 to 2625 oz.) of gold; besides which gold was received from a number of places in Lower Assam, and from the Bhutias.

Four methods of collecting gold were practised, according to Muniram:—(1.) The Kacharis (Cassaris) wait for a rise in the river, and immediately afterwards, on its fall, they scrape up the newly-deposited sand, which they wash for gold. (2.) All other Sonwals wash for gold during the dry season. (3.) The Rydegeea Phukun's Sonwals collect the leaves of the *copat* in the hills; these they burn, and collect gold from the ashes. (4.) The gold-washers in the Seedang (? Sittang) get the gold by washing the moss and slime which they scrape from the rocks in the bed of the river.

Some remarks are offered by Ball to explain the third method of obtaining gold which is mentioned by Muniram. That gold is ever taken up by plants and deposited in living vegetable tissue is not only improbable, but the fact that it is sometimes found among the roots of plants is considered to be attributable to the circumstance that it is a mineral not assimilated by plants, while the solutions in which it is carried into these positions are. Thus it is supposed that, the solvents of gold being absorbed, the metal itself accumulates by gradual increments. It seemed at first probable to Ball that the *copat* plant grew on the banks of the streams, and acted mechanically by arresting small particles of gold. But on inquiry, the *copat* would seem to be a common plant in Assam, and possibly belongs to the ginger family. Its leaves, being thin but strong, are commonly used to wrap up small parcels. Their connection with gold probably was that they were used to wrap up the gold, and the small three-cornered packets may have been burnt in order to save the fine gold adhering to the leaves; hence may have arisen the fable.

Colonel Hannay mentions that the soil found about the roots of trees, especially those of the tree-fern, are rich in gold. This calls to mind the fact that skins of animals are laid down in gold-bearing streams in Kashmir, and horns of wild cattle, with the hair attached, in Burma, for the purpose of arresting the spangles of gold. Indeed, the use of blankets in quartz-crushing mills is an application of the same principle. The velvety surface of young sprouting ferns growing on the banks of streams, might serve to arrest some gold, and these, if burnt, would yield an auriferous ash.

Colonel Dalton mentions a tradition of a nugget having been found attached to an edible root. This, of course, may have been a chance occurrence; but, on the other hand, it may be explainable as above.

The following is Muniram's account of the method of washing and collecting gold from sand:—

Wherever the current is strong, with a falling bank above it, ending in a sharp turn of the river, the Sonwals examine the opposite shore where the sand from the falling bank is thrown, and if this should contain gravel mixed with the sand, it is accounted a good place to find gold in.

Each party consists of a headman (*patoee*) and 4 assistants (*pallees*), who wash in one trough (*dorongee*). When they find a proper place to commence operations, they begin by working about in the sand with a sharp-pointed bamboo (*sokalee*), to find the depth at which the gravelly sand is; they then take it up in a piece of split bamboo (*bans chola*) and examine whether there is any gold-dust in it. If they see 12 or 14 bits, they immediately build their houses and commence operations. They first bund up the deep part of the stream, if it be a small one, with sand, and if large, with stakes and grass: the stream then takes a different direction over the sand; they allow it to wash away the upper surface of sand, so as to expose the gold sand, when the bund is re-opened, and the stream returns to its original bed. The upper sand is then scraped off, and the gold sand collected with a kind of wooden spade (*kater dohtal*). This shovel is 1½ cubits long by 1 cubit in breadth, with a handle 4 cubits long; the blade is of the form of a crescent, with holes at each corner, through which a string is passed, and 2 men lay hold of and pull this string, while another keeps pressing the spade down in a perpendicular position. The sand is then taken up in small baskets with handles (*cookees*), and thrown on a bamboo lattice-work or strainer (*ban*), which is laid over the trough. This trough is made of wood, and is 3 cubits long, 1 cubit broad, and 1 span high all round, with a slit 3 fingers wide at one end. Water is now thrown over the sand with a calabash having a large piece scooped out at the bottom, beside a very small hole on one side (*lao*); the water is thrown on with one hand, while the other hand is employed in moving the sand about, and sweeping off the larger particles of gravel from the surface of the strainer. In this way, the sand is spread on, and water poured over it; and as the trough fills, the water and dirty sand run off through the slit in it, while the clean sand and gold remain at the bottom of the trough, the trough being placed at a small angle to assist the water and dirt to run off quickly.

When 40 or 50 baskets of sand have been thus washed into the trough, the Sonwals call it a *shia*, and if a *rati* of gold is produced from one *shia*, they think themselves very fortunate indeed; for during the long days they get about 30 *shias* or washings producing 1 *rati* each, and during the short days about 25 *shias*, each party thus making on an average about ¼ *tola* (45 gr.) of gold daily. When they happen to fall on a good old stream that has not been disturbed for 5 or 6 years, they get 2 *ratis* of gold from every *shia* or washing, and then each party makes about ½ *tola* (90 gr.) daily.

The gold and sand of the last washing is collected into pottles (*chonga*), by spreading a leaf of *copat* or some other plant at the end of the trough, and dropping water very gently on the sand through the small hole in the calabash, which causes a parting of the sand and gold thrown on the leaf; when the whole is collected in this way, it is put into the pottle and tied up, and the next washing is commenced. As soon as they have collected enough in the pottles, they give up washing the common sand, but pour out the gold and sand from the pottles into the trough again, and putting in about an anna's weight of quicksilver for each *tola* (180 gr.) of gold-dust, they pour water over the sand to keep it in motion, while the quicksilver remains below with the gold-dust and forms it into a lump; this lump is then put into a shell on a fire of *nahar*-wood charcoal. When the quicksilver evaporates, the shell becomes lime; it is then carefully taken up in a spoon, and thrown into water, when the gold falls to the bottom. If it be of a brass colour, it is wrapped in a paste made of clay from the cooking *chulas*, mixed with a little salt, and burnt in a fire, which gives it a proper colour. This process causes an absolute refinement of the surface of the gold. It is the same used in gold refining by the natives generally; but in the latter case, the metal has to be reduced in the first instance to very thin leaves, to allow the muriatic acid fumes to penetrate and unite with the alloy.

A very large proportion of the gold which is obtained in Assam is "doubly derivative," coming from the degradation of the Tertiary rocks. In the upper reaches of the Brahmaputra, it is probably directly derived from the crystalline rocks. It is important, says Ball, that this should be clearly understood, and that the prospect of finding gold in its original matrix in the easily accessible parts of the valley of the Brahmaputra is very small.

Darrang district.—In the Darrang district, several of the rivers which join the Brahmaputra on the north are said to contain gold, which is still or has formerly been washed for. They are the Bhoroli, which is perhaps identical with the Bhairavi, the Burigang [Boongawn], and the Bargang [Burrowgawn].

The name of the Bhoroli river appears to be repeated in several parts of Assam, so it is uncertain which is referred to. A particular river which bears it, however, is said to have been noted for its gold. It joins the Brahmaputra 5 or 6 miles above Tezpur.

Under the name Bhairavi a river in Darrang is stated to yield gold of a superior quality. The name does not appear on the map, but from the indication of its position as rising in the Aka hills, it is probably the proper name of the Bhoroli.

The Burigang river, which rises in the Dufla hills, and joins the Brahmaputra near Bishnath, is said to contain gold.

The Bargang river rises also in the Dufla hills, and joins the Brahmaputra 3 or 4 miles above the last mentioned. Both for the quantity and quality of its gold, it is said to have been more noted than the Dikrang even.

Lakhimpur district.—This district appears to include a greater number of named and distinctly auriferous rivers and streams than the whole of the rest of Assam put together. The total yield of gold about 1853 was, according to Colonel Dalton, 20 lb. per annum, worth about 1200*l.* Here too, the Brahmaputra, or, as it is called above Debong Mukh, the Lohit, contains gold in sufficient abundance to be washed for. The principal tributaries of the Brahmaputra on the north which yield gold are the Dikrang, Borpani, Subanshiri, Sisi, Dihong, Dibong, Digara ; and on the south, the Joglo and the Noa Dihing.

Brahmaputra River.—Colonel Hannay states that about the year 1838, above Sadiya, a party of gold-washers, consisting of 12 men, washed for 20 days and realized 7 *tolas* (1260 gr.) of gold. In the vicinity of Tengapani Mukh, a party of Kacharis, 60 in number, washed for 5 days and realized 25 rupees' weight of gold; also 35 men for one month, who collected ½ *tola* (90 gr.) or 8 rupees' (16*s.*) worth of gold each. In the year 1853, the total outturn of the Brahmaputra was said to be 1 to 1½ lb. of gold per annum.

In 1855, Colonels Dalton and Hannay were requested by Government to make a further and more complete examination of the auriferous deposits of Upper Assam than they had previously done. They first commenced operations a few miles above the Bhramakhund gorge ; but finding the deposits less rich as they penetrated further into the hills, they returned to Parghat, 8 miles below Bhramakhund. Here the river debouches from the mountains, after cutting through an enormous deposit of earth and boulders to the depth of 150 ft. The gold obtained above Parghat contained a certain proportion of dendritic and crystalline particles, while below that point it consisted of flattened spangles, evidently the result of attrition. The actual source of the gold was not ascertained. At Bhramakhund are slates and felsites *in situ*. Travelled boulders of granite, gneiss, &c., were observed there, as also much white, ferruginous, and cellular quartz. The last was possibly the matrix of the gold.

Gold from the Brahmaputra, forwarded by Colonels Dalton and Hannay, which was assayed by Dr. T. Boycott at the Calcutta Mint, yielded only 88·281 per cent. of pure gold. This confirms an opinion of Muniram, that the gold obtained from the Kacharis was of an inferior character, because they always obtained it in the Brahmaputra. This gold was obtained partly in a Californian cradle worked by 4 men at Gurumora, 18 miles below Bhramakhund; 2½ tons of stuff which were passed through it yielded 30 gr., or in value Rs. 2·8 (5*s*.). In the native trough (*duruni*), worked by 3 men, the yield from 18 cwt. of stuff washed in one day was about 12 gr., or in value 1 rupee (2*s*.). The natives looked upon this as a poor yield, stating that after a flood they sometimes got double that amount.

Other rivers.—The Dikrang river has a long course, and enters Lakhimpur from the Dufla hills, if it does not rise in them. It was formerly noted for the quality and quantity of the gold found in its sands.

The Borpani river is said to be a tributary of the Pisola, a name not on the map. There is, however, a Borpani, a tributary of the Dikrang. It is said to have been more remarkable for the quantity than the quality of its gold.

There is little recorded about the Subanshiri river, but the average yield about the year 1853 was 3 to 4 lb. of gold. It was thus one of the most valuable.

Colonel Dalton estimates the average yield from the gold-bearing sands of the Sisi river to be 15 gr. to a ton. About 1 lb. of gold was obtained per annum from this stream.

The gold from the Dihong river contained 90·234 per cent. of pure gold. It is alluded to as being one of the richest in Assam. In the experiments conducted by Colonels Dalton and Hannay, 5⁵⁄₇ tons of gravel yielded 90 gr. of gold, or at the rate of 16⅛ gr. per ton. If the large fragments which can be removed by hand be excluded, the yield would be 22 gr. per ton. The Californian cradle used on this occasion was found to give proportionally more to each of the 4 men employed upon it than did either the native trough with its 3 men, or the Singpho washing-dish with 2. The annual yield was 2 to 4 lb. of pure gold apparently, but the name is (? mis-) printed Dibong.

The annual yield of gold from the Dibong river was estimated in 1853 to be 1 to 1½ lb.; another statement is that it is 2 to 4 lb. In one of these cases, it is evident that Dibong is a misprint for Dihong.

About 5 miles from its junction with the Brahmaputra, gold was found by Colonels Dalton and Hannay in the bed of the Digara river, but only in small quantities, and higher up stream washing was not successful.

The Joglo [Jugla] river rises in a range of small hills which stretch across from Jaipur to Sadiya. After a very short course, it falls into the Buri Dihing. In the Joglo, the soil and sand is scraped from the banks and washed; that which has collected about the roots of trees, especially about those of tree ferns, is considered to be most rich in gold. Allusion has been already made to this, and to the tradition that in this tract a native traveller found gold in lumps attached to an edible root. In olden times, it is said that from the richness of the gold here the area through which the river flows was kept as a royal preserve, and Muniram says that the gold brought by the Sonwals of this tract was the best in all Assam. In 1853, it was visited by Colonel Dalton, who states that it had been deserted by the gold-washers, in consequence of its costing more to propitiate the evil spirits of the place who guarded over the mineral treasures than they could afford to pay. As the spirits were not considered to be hostile to Europeans, Colonel Dalton, without any preliminary propitiation, set the washers who were with him to work. The ancient alluvial deposit here appears to be of considerable extent and thickness. A stratum of gravel, about 15 ft. above the highest water-mark, was proved to contain gold. The natives made use of a sluice by forming two embankments with bamboo and rubbish, thus dividing the river into three channels, which enabled them to turn the water in or out of the central channel into which they collected a heap of gravel. By means of sieves, they removed the larger pebbles, while the current carried away the finer sediment. The residue was then washed in pans with much more satisfactory results than usual. Colonel Dalton's rough estimate of the outturn was 18 gr. of gold to the ton of rubble which was washed. This was equal to about 8 gr. per man per diem. He points out that before the yield of this field can be properly ascertained, the base of the deposit should be examined.

According to Colonel Hannay, a party of 20 Kacharis, who washed in the Noa Dihing for 3 months, towards the end of 1837, obtained 10 *tolas* (3¾ oz.) of gold, which was sold at Sadiya at the rate of Rs. 12 (24*s.*) per *tola* (180 gr.). Their earnings, therefore, were Rs. 2 (4*s.*) per man per month. Colonel Hannay remarks on the fact that after the coarser portions are removed, the residue includes a number of minute and beautiful crystals of quartz. This has not been noticed elsewhere in Upper

Assam. During the examination made by Colonels Dalton and Hannay in 1855, the Noa Dihing was found to contain gold in larger proportions than the Brahmaputra, but only in the form of minute spangles, very liable to be carried away in the washing. The gold was found to diminish in quantity as the hills were neared. Traces of platinum were obtained with the gold.

Manipur state.—The operation of gold-washing as here conducted in the Ningthee river is thus described by Captain Grant (1832). The sand and gravel are first placed in a sieve, and the finer parts fall on to a hollow plank, 4 ft. long and 2½ ft. wide at the upper end, and 1½ ft. at the lower, which is open, the top and edges being protected by a rim or margin ½ in. high. The lower half is cut into grooves ½ in. deep and wide. The fine sand caught in these grooves is washed in a wooden dish, resembling a shield in shape, which has a polished black internal surface, and a receptacle in the centre; placed floating on the water, it is revolved till all the sediment is removed, and the iron sand and gold are left. By means of these implements, about 1 gr. of gold is got in ½ hour.

Sibsagar district.—The principal rivers whose sands include gold in the Sibsagar district are the Dhaneswari [Dhunsiri], with its tributary the Pakerguri, the Desue [Disoi], the Jangi [Janji], and the Buri Dihing; but the auriferous deposits on the flanks of the Naga hills extend throughout from the Dhaneswari to the Noa Dihing.

For comparison with the yields of other rivers, Colonel Hannay mentions that he was informed by the chief of the washers that in the Dhaneswari river 15 men obtained 7½ *tolas* (2 oz. 16 dwt. 4 gr.) of gold in 12 to 15 days.

On the Desue river, in Colonel Hannay's time, the gold-washers carried on their operations 1½ days' journey above Jorhat, where the bed is stony. Here the yield was about the same as in the Dhaneswari, 15 men having obtained 7½ *tolas* in 12 days.

Montgomery Martin has recorded that the Assam Government received into the royal treasury 1500 gr. of gold yearly from a gold-mine called Pakerguri, situated at the junction of the Dhaneswari with the Brahmaputra. There is some obscurity about this, as the Pakerguri joins the Dhaneswari a day's journey from the Brahmaputra.

The Desue and the Joglo rivers yielded the best gold in Assam, and the gold ornaments for the Raja's family are said to have been made exclusively from the gold obtained in them.

In the Jangi river, according to Colonel Hannay, 15 men washed for 12 days, and obtained 7½ *tolas* of gold.

Colonel Hannay mentions that a party of salt-traders, 24 in number, washed for gold for one month in the Buri Dihing river, and realized only 12 annas' weight, or about 12 rupees' (24*s.*) worth.

Banca.—An extract in the *Mining Journal* (xlix. 743) says that the occurrence of gold is only known in the Kajoe-Bessi valley (in the Pangkal-Pinang district) near Cape Bonga, where it must have been formerly found near the inland head, Mindim. It was, however, not discovered in the sandstones which occur at the place where it is at present found. However, it is possible that here, just as in a few other places, a little gold might be met with.

Borneo.—The greatest quantity of Bornean gold is furnished by Sambas, Landak, Montradak, and Borneo proper. Gold is one of the chief productions of Banjarmassin. The amount annually collected in the island cannot be ascertained, but the exports from Brunei have been as follows:—In 1870, $5789 (1206*l.*); 1879, $2258 (470*l.*); 1880, $3663 (763*l.*). On the other hand, the imports of gold from Singapore into Brunei, in 1880, were $3500, and the foreign imports of gold into Sarawak in the same year were $162, making a total only $1 less than the exports.

Crawford (1820) says that the practice of mining for gold from alluvial deposits in the Indian Archipelago is pursued by both natives and Chinese; but systematically, skilfully, and effectually, as to production, only by the latter. The chief seat of the Chinese mining operations is Borneo, and of that island principally the territory on its west coast, situated towards the mountains, and lying between the rivers of Pontianak and Sambas. The country is usually denominated Montradak, from the name of the principal town or village, which is situated about 2 days' journey, or rather voyage—as it is an inland navigation—from the coast. The whole tract is alluvial, and channelled by the beds of numerous rivers, some of them of great size. Crawford's information respecting the economy of the mines was principally got from personal communication with Chinese, who were for years engaged in them. The whole Chinese population of this part of the country amounts to 36,000, of whom 4000 only are women. Part of the latter are of the mixed Chinese and native race, the greater number being natives of the place, purchased or kidnapped. Six thousand of the whole of this population only are directly engaged in the working of the mines, the rest being occupied in trade or agriculture, or in branches of industry subservient to the working of the mines. Like the tin-mines of Banca, the economy and circumstances of which they very closely resemble in many particulars, the gold-mines of Montradak are divided into large and small. Of the first there are 13 at present wrought; of the second, 57. The principal difference in these consists, not in the amount or the fertility of the ore, but rather in the greater or smaller capital which is employed in working them, and of consequence, in the principle and extent to which the mining operations are conducted. The great mines are wrought by companies of persons of property and capital who employ monthly labourers. The smaller mines, on the other hand, are worked by the mere labourers, who at once conduct the operative parts, and share the proceeds on terms of perfect equality. The large mines employ 100 to 200 men, including labourers and overseers; the smaller, 10 to 50. The economy of the large mines is chiefly worthy of notice. The mode of paying the labourers is by monthly wages, with a supply of food. An inexperienced labourer receives for the first 4 months, 2 Spanish dollars a month; for the second 4 months, $4; and for the remainder of the year, $5. Ever afterwards he receives $6, and if he has capacity and integrity to make an overseer, $8; from the mode of making payment, as will be afterwards shown, there is a real advance of 30 per cent. on these wages. In defiance of the climate, the miners labour severely. They work about 12 hours a day, beginning their operations by break of day, or, if there be moonlight, earlier, not ceasing until half-past 6 at night, and taking very little time to their meals.

The mine is a longitudinal excavation following the course of the mineral stratum, and its breadth and depth necessarily depend upon the circumstances of that stratum. The situation of the ore is, however, commonly very superficial, not usually above 5 or 6 ft. from the surface; 40 ft. is a common breadth for the stratum containing it, and of course for the mine, and 10 ft. for its depth, making 15 or 16 ft. a common depth for the whole mine. The processes pursued for extracting the ore, for clearing the mine of water, and for washing the mineral earth, much resemble the same operations followed with the tin ore. The access to the mine is by the trunk of a forest tree, into which steps are cut. The ore is extracted and brought up by manual labour with spades and baskets. The largest mines are cleared of water by the Chinese wheel, and the mineral is washed in an aqueduct lined with the bark of trees, and supplied by a neighbouring brook with a stream of running water. In the large mines it is the practice to suspend the process of extracting the mineral, and to wash the auriferous earth at the end of every 35 days. A mine wrought by 200 labourers will afford in that time, as the largest produce, about 320 *bongkals*, or 555⅓ oz. Troy; and as the lowest, about 140 *bongkals*, or 243 oz. Troy. The following detailed statement will point out more fully the expenses and profits of the mining business as conducted by the Chinese:—

STATEMENT OF THE EXPENSES AND PROFITS OF A BORNEO GOLD-MINE, WORKED BY 200 LABOURERS.

Expenses.

20 overseers for 35 days, at $8 per month	$186	67	or	£42	0	0
180 miners for ,, $6 ,, ...	1260	00	,,	283	10	0
30 per cent. on wages of 200 men	434	00	,,	97	13	0

70 *piculs* ordinary rice, at $1 per *picul*	$70	00	or	£15	15	0
17½ ,, salt fish, at $2 per *picul*	35	00	,,	7	17	6
4 ,, salt, at $1¼ ,, ...	5	00	,,	1	2	6
2 ,, edible oil, at $15 ,, ...	30	00	,,	6	15	0
Interest of dead stock, and repairs of tools and machines ..	35	00	,,	7	17	6
Interest upon capital of $2000 67c., at 25 per cent., for 35 days	49	11	,,	11	1	0
Total charges	$2104	78	,,	£473	11	6

Profits.

Produce, 2000 *bongkals* of Montradak gold-dust, worth ..	$4848	00	or	£1090	16	0
Gross profit for 35 days	2743	22	,,	617	4	6
Annual profit	$28,607	89	,,	£6436	15	6

The gold of the Indian Islands, whether obtained from veins or mineral deposits, always appears in the commercial transactions of the country in the form of coarse sand or dust, that of the alluvial deposits being, from attrition, always smooth, and is of intrinsic value usually in proportion to the size and coarseness of the grains. In commercial language, gold-dust is designated by the name of the country which produces it, and that of the same country is pretty constantly of the same touch or fineness. Independent of the quantity of copper or silver always in combination with the ore, it invariably contains a considerable mixture of earth, iron, and other adventitious matters. The most productive mines, it may be remarked, afford gold of the lowest test, and that which contains the largest portion of mechanical admixture. The following table presents at one view the assay and value of some of the most common descriptions which appear in the markets:—

TABLE EXHIBITING THE VALUE AND ASSAY OF THE GOLD-DUST OF SEVERAL PARTS OF THE INDIAN ARCHIPELAGO.

Name of Gold, taken from the District which produces it.	Country where situated.	In 100 parts of Gold-dust.		In 100 parts of the metal.				Fineness, estimated.		Value per oz. of gold-dust.			Value of a *bongkal* or 833 gr. of dust in Sp. dol.	
		Dross.	Metal.	Gold.	Silver.	Copper.	Silver and copper.	In carats or scale of 24 parts.	By native touch or scale of 10 parts.					
										£	*s.*	*d.*	$	c.
Gold of Ombak ..	Borneo	3·75	96·25	88·19	8·51	3·3	11 81	21·17	8·82	3	12	1¼	27	81
,, Sanga ..	,,	4·96	95·04	90·97	3·65	5·38	9·03	21·83	9·10	3	13	5½	28	33
,, Larak ..	,,	3.83	96·17	86·11	5·90	7·99	13·89	20·67	8·61	3	10	4¼	27	13
,, Banjar-Laut	,,	2·66	97·34	90·45	4·34	5·21	9·55	21·71	9·05	3	14	9½	28	84
,, Pontianak	,,	14·05	85·95	82·99	16·14	0·87	17·01	19·92	8·30	3	0	7¼	23	37
,, Jambi ..	Sumatra	5·47	94·53	91·84	..	..	8·16	22·04	9·18	3	13	9	28	44
,, Sambas ..	Borneo	9·00	91·00	83·68	..	..	16·32	20·08	8·37	3	4	8¼	24	95
,, Palembang	Sumatra	2·11	97·89	93·75	..	..	6·25	22·50	9·38	3	17	11½	30	06
,, Montradak	Borneo	12·02	87·98	84·09	..	..	15·91	20·18	8·41	3	2	10¼	24	24

The chance of an increased produce from the mines of the Archipelago, says Crawford, will depend upon the share of tranquillity which the country enjoys, and the degree of freedom secured to its commerce. "Nothing further is requisite, for the ore, from all accounts, exists in inexhaustible abundance. This is most particularly applicable to Borneo, the immense alluvial tracts round the whole circumference of which everywhere contain rich deposits of this metal, from whence it necessarily follows that the primitive mountains of the interior must contain veins of it. From the abundance of the ore and the usual fascination of all mining projects, especially those in quest of the precious metals, the search for gold will be the first object to engage the attention of any enterprising and industrious people settled in the country, of whatever race. Amidst a great deal of anarchy and disorder, mining has of late years been prosecuted by the Chinese with surprising spirit. It is (1820) not above 8 or 10 years since considerable capital and the use of machinery have been applied to it, and in that time there has been a vast increase of produce."

According to J. H. Moor (1837), gold is found in almost every part of the Residency of the N.W. coast, in the *areng* strata. The gold of Sintang, Sanga, and Landak is about 9 touch; of Muntuhari, about 8½; of Mandor, a shade below 8; these are places under Pontianak. That found at Montradak, under Mampawa, is about 8 touch; under Sambas, of 9 touch; at Sapan, of 8: at Larak, of 8½; at Siminis, of 8; and at Salakao, of 7½. The mines are worked thus:—A shaft barely sufficient to permit the miner to turn round in, or at most 2 ft. in diameter, is sunk to the *areng* strata—a kind of yellowish gravelly earth mixed with various sized pebbles, and which also contains, at times, diamonds. This stratum is 1 to 3 ft. thick, and is dug out to the extent of 7 or 8 ft. from the sides of the shaft, under the upper strata, which sometimes are propped up; but this precaution is often neglected, which is the cause of frequent accidents. The *areng* is hoisted up in small baskets by bamboos, on the ends of which part of a branch is left, and forms a small hook. Small *dulans* (circular trays slightly converging towards the centre) are nearly filled with *areng*, and the workman (a Dayak, Malay, or Chinese), sitting himself in the nearest stream, immerses the *dulan*, and works the earth by hand until the earthy particles begin to separate; the *dulan* is then brought to the surface, and a rotatory motion is given to it, until the water it contains, being saturated with earthy matter, is poured off. This is continued till such time as the water comes away clean: the gold from its greater gravity collects in the centre. The Sultan of Sambas has a lump weighing 12½ *bongkals*, and says he has seen some weighing 25 *bongkals* (1 *bongkal*=832 gr.).

In Coti, says Moor, gold-dust is not procured in any very large quantities, although the country abounds in it. Coti gold-dust is considered equal in quality to that of Passier, and it might be got in large parcels; but the gathering of the nests in a great measure impedes the usual supplies. All the people conceive that where gold is sought after the birds invariably disappear; therefore, as birds'-nests are a much more profitable article than gold-dust, the Sultan has prohibited the searching for it under severe penalties. The Bugis, notwithstanding, contrive to get considerable quantities: in 1827, two prows only carried away 92 *catties* (276 lb. Troy). The usual price is 25 *reals* per *bongkal*. The Sultan had (1837) in his possession at Bongan, an immense quantity of gold, formerly the property of his uncle, Per Batti Sari, who died in Jan. 1828. This Pangeran came to Coti about 30 years before with 15 *piculs* (2100 lb.) of gold-dust, and thenceforward accumulated it from all quarters. By the Sultan's account, he left 18 *piculs* (2500 lb.) of gold, besides an immense sum in dollars and jewels; but the brothers of the Sultan and the Pangeran Seripa say the weight of gold-dust must be near 25 *piculs* (3433 lb.). The whole of this treasure belongs to the Sultan, and is buried in the ground at Bongan (according to the Bugis custom) in three different places, one of which only has hitherto been opened; it was found to contain that portion brought from Passier; the Sultan would not permit the other two depositories to be touched.

Hunt (1837) says that the principal gold-mines of Borneo are in the vicinity of Sambas. There is a mountain called Guming Pandan, about 80 miles inland; from this branch out rivers; one leads to Mampawa, one to Batu Bulat, near Tunjong Mora, and one to Landak; the whole intermediate area between the rivers is a firm, yellow, argillaceous schist or a ferruginous quartz, interspersed with vitreous ores, of a remarkable dark-reddish colour, abounding with the richest veins of gold, and equal if not superior to any mine extant. There are only 50 *parets* or mines now wrought in the whole kingdom of Sukadana, 30 of which are in the Sambas district, each mine having at least 300 Chinese employed. Their pay, one with another, is $4 (16*s.* 8*d.*) *per mensem.*

The mines are rented from the Raja at the rate of 50 *bongkals* (86⅓ oz.) of gold per mine per annum, besides a capitation tax of $3 (12*s.* 6*d.*) per head on every Chinaman. There are 30,000 Chinese in the Sambas district, and they feel themselves strong enough to oppose or evade this tax; it hence becomes a perpetual contest between greedy extortion on the one side and avaricious chicane on the other; there are besides about 12,000 Malays and Dayaks.

The Larak gold-mines are situated to the eastward of the town of Sambas, and are particularly rich and productive. The mines of Siminis are a day's journey from Sambas, up a small creek leading to

Sambas river, below the town; and the mines are abundant. Salakao is up a river, 15 miles south of the Sambas river; it lies nearly 40 miles up, but communicates with Sambas by another river; here the metal is found more abundant than anywhere else; and 20,000 Chinese are in this district. Montradak is 3 days' journey up the Mampawa river; it is under an independent Malay prince. Some accounts make the population of this district great, near 50,000 Dayaks, Malays, and Chinese; but perhaps half the number may be nearer the truth; these are chiefly employed on the gold-mines and in producing food for the miners. These mines, however, do not produce that quantity which they might under Chinese management. Mandor is about a day's journey from Pontianak, and belongs to the Sultan; it is reckoned a very rich mine, though but recently wrought. There are as yet only 12 *parets* of about 200 men each; but it is capable of extension. Numbers of Chinese are settled in this district, and the population is annually increasing.

About 3 days' journey up the Pongole river, lies the district of Sanga, with a population of 25,000 souls, Dayaks, and a few Chinese, under a Malay independent prince. The population is chiefly employed on the rich mines of gold in the neighbourhood, which is particularly pure and abundant; but the mines are not wrought with the same industry as those under the Chinese management. The Dutch thought it of so much consequence as to keep a force at Sanga, and to place the present Rajah on that musnud. About 2 days' journey farther up, lies another gold district, called Sintang, the inhabitants of which are principally Dayaks. Beyond Sintang, and higher up on the same river, lies the town of Sukadana, abounding in gold, the inhabitants of which are also Dayaks.

The Matan mines of gold are abundant, and capable of becoming highly productive. About 3 days' journey from Pontianak, lies the celebrated mountain of Landak, which, "after Golconda, is the most valuable diamond mine in the world." Here also much gold is produced, and much more might be had under proper management.

There is a very valuable gold-mine in the north of Borneo, at a place called Tampasuk, situated in the district ceded to the English by the Sultan of Solu; but having become the principal pirate port on the coast, the working of the mine has been discontinued.

The whole produce of the gold-mines of Sukadana is said to be annually about 20 *piculs* (3433 lb.), or $1,000,000 (200,000*l.*), at $25 (5*l.*) a *bongkal* (832 gr.); but no calculation of this sort can possibly be correct. Living, as the Chinese do, under the rapacity of despotic and ferocious freebooters, who are actuated by no one principle of honour, justice, or good faith, it is their interest to conceal the riches they amass, not only to preserve themselves from the clutches of these tyrants, but as the most compact substance to transport to their native shores, to which they repair with the fruits of their industry, by the annual junks that arrive at Pontianak, leaving the mines to new settlers; 200 or 300 leave Pontianak every year.

The standard of Salakao gold at Pontianak is fixed at 23 Spanish dollars the *bongkal* of $2 weight. The Sanga and Larak is $25 the said *bongkal*.

Not having had an opportunity of inspecting any of the gold-mines personally, Hunt does not know if the ores readily melt of themselves, or whether they require the aid of any fluxes before they yield the metal; but he believes the principal attention of the miners is directed to the rich veins of pure native gold, and that no operation is performed beyond that of pulverizing, and simple washing; all the gold about Pontianak being in dust, though some he met with in Borneo proper was run into bars.

At Manday, on the north-east coast of Borneo, in the province of Mangidara, is a very rich mine of gold.

Passier and Coti, in the Straits of Macassar, produce considerable quantities of gold; and gold and diamonds are brought down by the river to Banjarmassin.

Dr. Leyden (1837) enumerates among the productions of Banjar, gold of a finer touch commonly than that of Sambas, which is only 7 touch, whereas that of Banjar is often 8 or 9. The gold-mines at Banjar are said to lie very near the surface, at the depth of about 3 fathoms. Those at Kirsan and Duku, which are very rich, lie in a red marl; above the mine generally lies an incrustation like ratan-wood, beneath which the gold-dust is found in a red earth.

J. Brooke (1842) says that the quantity of gold yearly procured at Sambas is moderately stated at 130,000 *bongkals*, which, reckoned at the low rate of 20 Spanish dollars a *bongkal*, gives 2,600,000 Spanish dollars, or upwards of 500,000*l*. sterling. The most intelligent Chinese are of opinion that the quantity in Sarawak exceeds that at Sambas.

Capt. Sir E. Belcher (1848), alluding to the gold-mines at Selingok, about 8 miles inland from Kutching, on the river Sarawak, says the gold is obtained by washing, from a very loose disintegrated granitic débris, containing detached crystals of quartz—dodecahedrons, or 6-sided pyramids, base to base—pyrites, antimony, and traces of tin. Much of the light gold is lost in the washing.

Logan (1856) mentions several gold-mines on the Kapuas, the principal river on the W. coast; the gold is found at 15 to 30 ft. below the surface, and the gold-bearing stratum is about 4 ft. thick. The earth containing the gold is piled up, and washed once in 3 or 4 months; the earth is thrown into a ditch, planked for the purpose, about 2 ft. wide and 1½ ft. deep, water is turned on, and the earth is stirred with spatulas or hoes; the water carries away the earth and sand, the gold and pebbles remain, and are separated by the *dulan*.

Spenser St. John (1862) remarks that washing only is employed, no deep sinkings have been attempted, nor quartz discovered in large quantities, and it is not likely to be whilst most of the country is clothed with forest. Nearly all the gold-working in Borneo is done by *kunsis* or companies, which sometimes number several thousand men, generally, however, only a few hundred. He thus describes the mode of working by the Chinese at Bau. They dam up the end of the valley, forming a large reservoir of water ¼ mile long. The dam is completely faced with wood, towards the water, and partially on the outside, to resist the tropical rains. A ditch 4 ft. wide is cut from the reservoir to the ground selected to be worked; a sluice-gate in the dam regulates the supply of water to the main ditch, and minor sluice-gates to it regulate the supply to the smaller ditches. When this is all prepared, the sluice-gates are opened, and the earth in its neighbourhood is thrown into the ditch; the rushing water carries off the mud and sand, and allows the particles of gold to sink to the bottom. After 3 or 4 months, they clean out the ditch, and carefully wash the residue, which generally yields them sufficient to make a tolerable division among the workmen after all the expenses are paid. It is a most wasteful mode of working, for by rewashing the tailings, the women and children obtain as much gold as the men.

That there is an abundance of gold to be found there, St. John adduces as an instance, that in Nov. 1848, a great landslip took place, and the face of the Trian mountain was laid bare. Thousands of Chinese washed it all in about 6 weeks, and none got less than 1½ oz. per month of gold. He saw a nugget picked up weighing 7 oz. From Siniawan to Bau, 10 miles, are a constant succession of reservoirs and gold-workings. On the limestone hills of Piat, he found a large party of Malays seeking gold in the quartz which lines the crevices and caves of these hills.

Boyle (1865) says that a considerable amount of gold-washing is done at Bow [Bau] on the Sarawak river, and, as every flood brings with it a fresh supply, it is evident that it exists in greater quantity in the high lands through which the head-waters of the river flow.

According to Crocker (1881), many years ago Rajah Brooke encouraged some Kay Chinese to try the gold-field at Marup, about 100 miles up the Batang Lupar river. Since then an extensive area has been proved, and for many miles an alluvial deposit is found, yielding gold in paying quantities, and sometimes in pockets.

Sarawak.—The following notes on gold in Sarawak are taken from Everett's pamphlet quoted at the end of this volume, by the kindness of W. M. Crocker, Esq.

Gold occurs in the form of fine sand or flattened plates in alluvial deposits over a great part of Sarawak. Washings are carried on in Upper Sarawak, at Bau, Paku, Gambang, and in Samarahan, at Sirin, in Sadong, at Malikin, and in the Batang Lupar, at Marup. The operations are wholly superficial, although at Bau and Marup, the principal Chinese washings in the country, the stratified clays belonging to the sandstone formation, and containing at the former locality decomposed porphyritic dykes, have been cut into to some extent ; but the precious metal has never been regularly mined for, nor, indeed, has it been discovered *in situ*, except in the case of the gold contained in the veinstones and quartz reefs of the antimony district, and associated with a lode of argentiferous arsenic at Bidi.

The alluvion of the limestone caverns and fissures, and especially the sands in the beds of streams, have yielded sufficient to induce the natives to work in such spots. The washing is carried on partly by Malays, but chiefly by country-born Chinese from Sambas.

Nuggets are of extremely rare occurrence and of small size ; but if the Chinese are to be credited, some of considerable weight have occasionally turned up in the adjacent Sambas district. St. John mentions having seen one of 7 oz. taken from the auriferous clay at Trian, near Bau, and this is probably the largest ever found in Sarawak. The gold-dust is usually in a state of the finest comminution ; but samples from Kunpang, near Marup, are composed of fine dust intermixed abundantly with thin flat plates of the metal of $\frac{1}{3}$ to $\frac{1}{2}$ in. diameter—a form which has been ascribed to some original laminated structure in the parent matrix. Similar lamellæ are said to have been detected in the siliceous veinstones of the antimony lodes ; but where Everett had the opportunity of seeing the gold in these situations, it appeared in sparsely scattered specks, without a sign of running into plates or veins. The veinstones are now and again found to contain a very profitable percentage, and the Chinese quarry the stone in a superficial way, and pound it in wooden mortars with iron rammers. One block of siliceous matrix (about 15 lb.) at Paku, containing some 20 per cent. of grey antimony, yielded when thus crushed about $12 (50*s*.) worth of gold ; but this result was considered quite exceptional. At Jibong, both white quartz and black siliceous veinstone are crushed, and, of these two, the latter is thought to yield the higher percentage of the metal. Both in crushing, and in washing from the alluvial clays, the find is very uncertain, and good "hauls" seem to be few and far between. Marup, Bau, and Paku have afforded remunerative washings, and Sirin in a less degree. The succession of the superficial deposits in the last named locality is as follows :—(1) vegetable mould, (2) unstratified felspathic clay, (3) clayey gravel, (4) uptilted indurated clay-shale. The whole section to the basement-rock of clay-shale is only 5 ft. in thickness, and it is in the gravel stratum that the gold is found associated with small rolled fragments of cinnabar, and with the clay-ironstone which abounds all over the gold and antimony districts of Sarawak.

The components of the auriferous gravel are quartz, sandstone, impure agate, porphyrite, &c. The surrounding country is made up of steep low hills of indurated clay-shale and clayey sandstone, with yellow felspathic clays overlying, and is seamed with dykes of hornblendic trap-rock; at a short distance to the S., limestone hills appear.

The quality of Sarawak gold varies with the locality in which it is found. Thus Marup dust sells at $32 (6*l.* 13*s.* 4*d.*) or even $34 (7*l.* 1*s.* 8*d.*) per *bongkal* (1 oz. 14 dwt. 16 gr.), according to the supply, Sadong gold at $26 (5*l.* 8*s.* 4*d.*), whilst Paku gold is quoted at $28 (5*l.* 16*s.* 8*d.*), the difference being estimated by the whiteness of the metal, which is dependent on the amount of silver existing in natural alloy in it. No scientific analysis of Sarawak gold has been made.

With regard to the annual production of gold in the territory, there are no reliable data for even approximating the total amount. Low puts the yearly export at 7000 oz. in 1840. Although nominally all gold carried out of the country must be declared, it is beyond doubt that quite as much is exported in a private way as is declared at the export office in Kutching [Sarawak], whilst a large portion of the total yield is bought up in the country, and does not show in the trade returns.

In connection with the consumption of gold in the territory, it is a noteworthy circumstance that none of the savage tribes of this part of Borneo seem ever to have made use of this metal, notwithstanding their intercourse with Malays, and in a less degree with Chinese, during so many centuries past. Everett never knew an instance of a Sea- or Land-Dyak, a Kayan, Bakatan, or native of other wild tribe, seeking gold on his own account, or manufacturing it into any description of ornament, however rude.

In tracing the origin of gold in Sarawak, it is evident that the immediate source of the metal is in the alluvial clays and gravels, and in certain of the clay-shales which so thickly mark the older formations in N.W. Borneo; out of these it is being swept continually into the streams. But Everett, from observation of a considerable number of sections in different parts of the country, comes to the conclusion that the auriferous strata of Sarawak Proper have been derived immediately from the waste of porphyritic and especially siliceous dykes, associated with the system of arsenic and antimony lodes developed in that neighbourhood; and that in other localities (the Batang Lupar washings for instance), similar strata appear rather to have been re-arranged more than once, so much so that the original home of the gold they contain can no longer be guessed at with certainty. The only clue to the problem in these latter districts is to be found in the circumstance that there is invariably evidence of considerable metamorphic action among the constituent rocks of the various localities. It is highly probable that much of the gold originally lay in quartz rock, as is the case in many places in Sumatra and in the Malay Peninsula, and may still be the case in the less known parts of Sarawak. "But, even if auriferous reefs are discovered at a future day, it is open to doubt whether they will afford a field for European speculation, especially since an analysis of the auriferous veinstones at Bau, by a competent metallurgist, has failed to give such a result as to tempt further operations."

BURMA [BRITISH].—Within the limits of British Burma, says Ball, gold has been found in the beds of the Irawadi and some of its tributaries, in the Pegu division, and in the beds of the Sittang and tributaries. The Tavoy river, and the Great Tenasserim and tributaries, in the Tenasserim division, also contain auriferous sands; but the gold-washer's trade appears to be very unremunerative. So far as is known, no gold has been found in the Arakan division.

Pegu division.—Theobald (1873) says that gold is occasionally washed for in the sand of the Irawadi, opposite Prome (18° 47′ 53″ N., 95° 18′ 18″ E.), but in such fine dust and so sparingly that few engage in the task of washing for it. He witnessed the process at Shwe-gyeng [Shuaygyeing] ("gold scratching"), in 19° 2′ N. and 95° 5′ E., and not to be confounded with the place of the same name in the Tenasserim division. The gold is found in a coarse gravel bank, left dry by the river when it subsides after the rains. This coarse gravel is dug out and laid on a sort of hurdle, which permits the fine sand to pass through, the coarse pebbles and boulders being rejected. The sand is washed on an inclined board, the lighter portions being gradually swept down the incline by a stream of water directed over it, whilst the heavy auriferous sand remains, and is from time to time collected. This sand is lastly washed in the common wooden hand dish, of circular form, and the gold it contains is collected by amalgamation. The profits are small, not more than 2 or 3 *annas* (3 to 4½*d.*) a day per man.

Tenasserim division.—Capt. Wyndham (1853) visited the gold-washings, which are situated near the junction of the Shwe-gyeng [Shuaygyeen] and Moot-ta-ma rivers, about 10 miles S.W. of the town of Shwe-gyeng (17° 54′ 40″ N., 96° 51′ 15″ E.) on the Tsit-toung [Sittang]. The washings are known to be of great antiquity, and in the time of the native government, there was a farmer-general who paid a certain sum to the royal treasury, and sublet the privilege of washing to numbers of persons. Specimens of the sands obtained by Wyndham were examined by Dr. Oldham, with the result that, in ⅛ cub. ft., 0·75 gr. of gold was obtained by washing, and an additional 0·20 gr. by amalgamation; in all 0·95 gr. The sand consisted of particles of metamorphic rocks, with schorl and magnetic iron. Two nuggets purchased in the bazaar, and which may have come from the Shan States, were imbedded in quartz. The gold-dust contained 92 per cent. of pure gold and 8 per cent. of silver.

The occurrence of gold of fair purity being undoubted, the question remains as to the amount in which it may occur, and the probability of its yielding a profitable return. If the specimen of auriferous sand forwarded by Capt. Berdmore be taken as a fair average sample of the kind of soil, and of the amount of gold contained in it, it would follow from Dr. Oldham's examination (by which means nearly 1 gr. of gold was procured from about ⅕ cub. ft. of soil) that 1 cub. yd. of the same sand should afford about 135 gr. of gold. Or, rejecting from the calculation the portion obtained by amalgamation, viz. 0·20 gr., the yield by washing alone would be 101·25 gr., or say an average of 100 gr. of gold for each cub. yd. of the sand washed. This sand is stated to be the surface soil, and being therefore readily accessible, 2 men could with great ease raise and wash 1 cub. yd. in a day. There would therefore be 100 gr. of gold as the remuneration for 1 day's work for 2 men, or 50 gr. per man per day. This gold would be worth about 3*l.* per oz.; that is, the produce per man per day would be equivalent in value to $\frac{50}{480}$ of 3*l.* or 6*s.* 3*d.* per day—an ample remuneration for ordinary workmen, but scarcely sufficient to tempt many adventurers to visit the locality. Dr. Oldham concludes by stating his belief that at least half the gold present is lost.

This locality was subsequently visited by Theobald (1863), who says that the auriferous beds presented much resemblance to those containing gold in Russia, and described by Murchison in his 'Siluria.' From the marked scarcity of quartz pebbles, he concluded that quartz was not the sole matrix; he believed that the gold was derived from the rocks near the sources of the Moot-ta-ma, and his estimate of the daily earnings of the washers was only 5 *annas* (7½*d.*) per man. Later on (1866) some Chinese tried washing here, but did not find the work sufficiently remunerative, so they gave it up.

Abernethy (1867) an Australian miner, aided by the government, penetrated further than the Chinese usually worked, but was unable to make the undertaking pay. He condemned the sources of the gold as being steep and rocky, and having a hard smooth ledge, upon which gold is seldom found in paying quantities. He also examined the sources of the Baw-ga-ta with much the same result. None of the accounts quoted state whether there are any quartz reefs in this region or not.

Mason found gold in the streams which fall from the granite ranges between Yay [Re] (15° 15′ N., 97° 53′ E.) and Monmagon [Moung-magan]; and states that gold was found by O'Riley with the tinstone at Henzai (14° 48′ N., 98° 10′ E.)

Gold is also said to occur with the tin ores which are found east of Tavoy (14° 5′ N., 98° 10′ E.) The richest deposit is one of red earth and pebbles near the source of the Tavoy river. On the eastern side of the range, at the base of which this deposit rests, the Siamese Government, according to Dr. Morton, who is quoted by Mason, employ several hundred men permanently to wash for gold; each man is expected to find one *tical* (252 gr.) weight, or about 20 *rupees*' (40*s*.) worth of gold per annum. In former times, the Burmese Government exacted a similar service on the Tenasserim side. A native officer in Tavoy obtained about 10 *rupees*' worth of gold in 9 days' washing. The composition of this gold, according to an assay at the Calcutta mint, was—gold, 87·895; silver, 9·241; base metal, 2·864; total, 100.

According to Dr. Helfer (1839) almost all the tributaries of the Tenasserim river contain gold. Near the old town of Tenasserim (18° 8′ N., 98° 55′ E.), there are, or used to be, pits sunk in the alluvium from which gold was obtained. It is stated that the workers sometimes obtain 1 or 2 *annas*' weight during the season.

BURMA [UPPER.]—The use of gold in Burma, says Ball, both for the purpose of ornamenting buildings and decorating the person, is universal throughout; but it is perhaps more prominently brought to notice in the cities and towns of Upper Burma. A portion of this gold is obtained from washings in the country, but by far the greatest amount is imported from China. Spears, as quoted by Dr. Oldham in 1855, estimated the average imports at 1100 lb., and the indigenous gold which was brought to the capital at 360 lb., making a total consumption of 1460 lb. Except when manufactured into leaf, the export was prohibited. It seems probable that the gold of Upper Burma is more frequently "doubly derivative," like the gold of Assam, than is that of Lower Burma, which in some instances certainly comes directly from the crystalline rocks.

Captain Hannay enumerates gold with other products of the Hukong valley. It is found both in dust and in pieces of the size of a large pea. The rivers which produce the greatest quantity are the Kapdup and Nam Kwan; pits are dug on the banks of the former, and the gold is found in the old alluvial deposits. In quoting the above account, Dr. Anderson adds to it that he was told by a Kamthi Shan, and by the Chinese at Momein [Moulmein], that gold is abundant near the supposed junction of the two main streams of the Irawadi, in the Kamthi country.

Placer gold is found in some streams entering the Kyen-dwen river from the west, near Kannee Myo (22° 30′ N., 95° E.) The mode of collecting the gold is very curious. Horns of the wild cow (*Bos sondaicus*), with the hair on, are planted in the beds of the rivers to arrest the gold and, when charged with the spangles, are sold for 12 or 13 *ticals* (1*l.* 12*s.* 6*d.* to 1*l.* 15*s.*) each.

In the upper parts of the Irawadi, both at Bhamo [Bamo, Bamoo, Banman] and near Thingadhaw, where the coal-mines are, gold is obtained in the sands. Near the coal-mines of Ket-zu-bin, which are some miles due south of those of Thingadhaw, Dr. Anderson states there is a small rivulet which is auriferous; he was informed that a single washer could earn the equivalent of 3*s.* a day. A few miles nearer Thingadhaw, the Ponnah creek contains gold; but the washers are described as being miserably poor: they stated that much larger quantities were obtained at Shwe-gyeng, 2 days' journey northwards. Dr. Anderson also records that when at Bhamo he was shown a small quantity of gold, in grains as large as peas, which he was told came from a hill to the north of the village of Ponline. Yule (1858) says it is brought to Bhamo from the Kyen-dwen river; and (1875) that the Kakhyens do not now bring gold for sale to Momein, though it is found to some extent in their hills, more especially in the direction of Mogaung, whence it is exported towards Assam. Marco Polo says a good deal of gold was found in the province of Caugigu: great doubt exists as the locality meant, but Pauthier considers Laos the most probable, and Yule agrees with him. Gold is also found largely in Coloman, adjoining. The Laos or Chians occupy territory contiguous to Burma and Siam, and enjoy semi-independence.

CELEBES.—Tavernier (1678) remarks that the "Island of Celebes or Macassar produces gold also, which is drawn out of the rivers, where it rowls among the sand."

According to Stavorinus (1759), it appears that Celebes contains much gold, and that in the neighbourhood of Pavigi, which is situated upon the Gulf or Bay of Tomini, gold is found by digging about 4 ft. under the surface of the earth.

J. H. Moor (1837) indicates the auriferous wealth of Mamoodjoo in Mandbar, on the west coast of Celebes. One of the principal rajah's brothers told him he would within 5 days produce 10,000 *bongkals* (17,354 oz.) of gold, 5000 of which should be in lumps of 1, 2, and 3 *catties* each, if he would in return give muskets, Palembang-made cannon, gunpowder, and 5 chests of opium; and in the course of 1 yr., he would engage any quantity (for similar articles), in pieces of 5 to 10 *catties* of gold, if they should be preferred to the small lumps or dust. In fact, he said, the quantum of gold which he himself and his brothers could produce would be equal to the payment of the largest importation of arms and ammunition; and the policy among them was to bring forward no more than was absolutely necessary for such purchase. That such is their policy, Moor is almost certain; and there is but little doubt that large quantities of the present gold could be procured, for particular parts of the country abound in it. Great care is taken to keep strangers from it, so these rajahs have only to shake off their slothful habits, and go with their people to collect it.

According to Bickmore (1868), the most valuable export from the Bay of Gorontalo (Tomini) is gold, which is found in great quantities, at least over the whole northern peninsula, from the Minahassa south to the isthmus of Palos. The amount exported is not known, for, though the Dutch Government has a contract with the princes to deliver all the gold obtained in their territory to it at a certain rate, they are offered a much higher price by the Bugis, and consequently sell it to them. No extensive survey has yet been made in this territory, by the mining engineers employed by the Government; the extent and richness of these mines are therefore wholly matters of the most uncertain speculation. The fact, however, that gold was carried from this region before the arrival of Europeans, more than 340 years ago, and that the amount now exported appears to be larger than it was then, indicates that the supply must be very great. The Government has not yet granted to private individuals the privilege of importing machinery and labourers, and proving whether or not mining can be carried on profitably on a large scale. A fragment of rock from this region was shown to Bickmore at Kema, by a gentleman who said he knew where were large quantities of it; and that specimen certainly was very rich in the precious metal. Gold is also found in the S.W. peninsula of Celebes, south of Macassar. The geological age of these auriferous rocks is not known.

CEYLON.—According to Dixon (1881), the island of Ceylon is referred to by Ptolemy as containing gold; and Solinus, a noted historian, makes mention of it in his works, A.D. 238. The early inhabitants of Ceylon were not ignorant of its presence. It is referred to in the Maháwanso; while, during the founding of the Ruwanveli Dágoba at Anurádhapura, there was a sudden appearance of sprouts of gold above and below the ground, and of silver in the vicinity ofAdam's Peak. It is also referred to in the Singhalese works entitled Kadayim-pota, as being found in several localities; and the names of many places either have reference to its occurrence or to their glistening appearance resembling gold, such as Ruwanvella, Ramboda (formerly Rangboda). The Singhalese name for gold is *rang*; for gold ore, the term *amurang*, signifying unripe or unextracted gold; while *ratrang* refers to melted gold.

In 1854, gold was found in the Mahaoya and at Nuwara Eliya, and still later again at Nuwara Eliya. There is a great similarity between the hill regions of Ceylon and the S.E. Wynaad district at the N.W. base of the Nilgiris, which has recently become so prominent on account of its auriferous reefs. As to the probable age of these districts, there is uncertainty ; but there can be no doubt that the two regions are contemporaneous, consisting of granitoid schists or gneissoid rocks, that they are highly metamorphosed, and that quartz reefs form a conspicuous feature.

The reefs are often white, occasionally somewhat brecciated, and not unfrequently bound together by hæmatite or limonite. Although the strike of the rock is peculiar in the Nilgiris to E.N.E., yet the auriferous reefs run N.N.W., corresponding with the gneiss a little further to the N. The general run of the rocks here is N. to N.W. As on the Wynaad, there is an absence of intrusive rock—no dykes, porphyritic masses, nor basalts. It has been observed that the auriferous belts are richest where micaceous and chloritic rocks occur. Strange to say, in the cuttings of the railway into the hill district, and the various cuttings on the public roads, no prominent reefs have been crossed. Probably one or more may be met with on the extension of the railway from Nawalapitiya to Nanu-oya. In several parts, the country is traversed by large persistent reefs of quartz, with numerous narrow seams and veins diverging from them, and often traceable into decomposed lithomargic earth. Some good examples of these are to be found in the Balangoda, Pusselláwa, Ramboda, and Dolosbágé districts. The character of the vegetation in prospecting for gold is of great assistance in Australia, where each formation is characterized by distinct forms of vegetation ; but in Ceylon there is no such guidance, as the mountainous zone is but one formation.

As scattered grains or nuggets, Dixon met with gold in the alluvium of the Deduru-oya beyond Kurunegala. The particles were exceedingly small, and other metallic matters were not uncommon. This must have come from some quartz reefs farther up the hills. Its occurrence in this river is referred to in the Kadayim-pota. A second instance of its occurrence in this form was in the Galle district, where a small nugget was taken from the alluvium accumulated in one of the ravines ; it weighed over 6 gr., and was associated with fragments of gems, such as sapphire, garnet, chrysoberyl, tourmaline, zircon, as well as of sulphides of some rare metals, due to disintegration of the matrix in which they occurred originally. Dixon followed up the ravine to its head, with the expectation of finding a quartz reef from which the gold must have been dislodged. He found two small reefs crossing it, and specimens from these gave traces of gold, but not in sufficient quantity to warrant its being worked. He had further specimens from this reef of a much better character.

In grains and leaves as free gold, from quartz, it occurs in the Ramboda district, Central Province, where several remarkable reefs strike across the valleys. In one of Dixon's tours, he gathered numerous specimens of quartz of various hues, chloritic and micaceous rocks. On breaking them up and examining, he found in the quartz traces of gold, but is unable to give the precise locality. It occurs in the pyrites of the gem-pits in the Ratnapura-Rakwána districts, but only in very small quantity. From the little Dixon saw, it is his opinion that considerable quantities will yet be brought to light.

It is elsewhere stated that the richest specimen of gold-bearing quartz yet discovered in Ceylon was on the Theberton estate, in the Maskeliya district, where are frequent outcrops of quartz reefs, and where gold has been washed since time immemorial.

Sir J. Emerson Tennent (1860) says that gold is found in minute particles at Gettyhedra, and in the bed of the Maha-oya and other rivers flowing towards the west. Ruanwelle, a fort about 40 miles distant from Colombo, derives its name from the sands of the river which flows below it (*rang-welle* = "golden sand"). Rang-galle, in the central province, is referable to the same root—"the rock of gold." But the quantity hitherto discovered has been too small to reward the search. The early inhabitants of the island were not ignorant of its presence.

CHINA.—Pumpelly (1867) gives the following table of gold-washings and -mines in China:—

TABLE OF GOLD-WASHINGS AND -MINES IN CHINA.

Province.	Department.	District.	Place and Circumstance of Occurrence.
Chi-li	Shun-tien-foo (Peking)	Mi-yun-hien	Gold-mine 8 *le* * E. of city.
	Yung-ping-foo	Tsien-ngan-hien	Gold-washings in the Kae-ho river.
	Do.	Lu-lung-hien	On Mount Tsoo.
Shen-si	Si-ngan-foo	Lin-tung-hien	On Le mountain, 2 *le* W. of the city.
	Shang-chow	Lo-ngan-hien	Coarse wash-gold at Hwang-lung-shan, 80 *le* N.E. of city, and rich washings at Yang-hwa-shan.
	Han-chung-foo	Si-heang-hien	Gold.
	Hin-ngan-foo	Han-ying-ting	Coarse gold in the Han river.
Kan-suh	Lan-chow-foo		Coarse wash-gold.
	Kung-chang-foo	Min-chow	Do.
		Keae-chow	Do.
		Wăn-hien	Do.
	Si-ning-foo	Si-ning-hien	Do.
	Suh-chow		Gold 70 *le* W. of the city at Tung-ting-shan.
	Chinsi (Barkaoul)		,, 60 *le* E. at Kin-shan.
Shan-tung	E-chaou-foo	Lan-shan-hien	Gold and silver mine 90 *le* S.W. at Paou-shan, and gold 60 *le* N.
	Do.	Kü-chow	Gold 100 *le* N. at Chi-paou-shan.
	Tsing-chaou-foo	Lin-kü-hien	Gold-sand 60 *le* S.W. at Sung-shan.
	Tung-chaou-foo		Gold.
Hu-pih	Hwang-chaou-foo	Hwang-kang-tien	Wash-gold 140 *le* N. at Tang-king-shan.
	Do.	Hwang-ngan	Gold E. at Tsang-kia-shan.
	King-chaou-foo		Gold.
	Shi-nan-foo	Kien-che-hien	Coarse wash-gold 15 *le* W. at Shi-jou-shan.
Sze-chuen	Ching-tu-foo	Kien-chow	Coarse wash-gold.
	Do.	Wang-kiang-hien	Do.
		Tsung-king-hien	Do.
		Pang-hien	Do.

* 1 *le* = 486·176 yd., or 444·423 mètres.

TABLE OF GOLD-WASHINGS AND -MINES IN CHINA.—*continued.*

Province.	Department.	District.	Place and Circumstance of Occurrence.
Sze-chuen *contd.*	Miew-chow		Coarse wash-gold.
	Do.	Ngan-hien	Nugget-gold N.E. at Kin-shan.
	Ning-yuen-foo	Yen-yuen-hien	Gold 30 *le* W. at Ho-kin-ho-shan, and very coarse gold 150 *le* N.W.
	Paou-ning-foo	Kwang-yuen-hien	Coarse wash-gold.
	Do.	Pa-chow	Do.
	Do.	Kien-chow	Do.
	Chung-king-foo	Yung-tsang-hien	Gold-washings.
	Do.	Hoh-chow	Do.
	Do.	Fuh-chow	Do.
	Yu-yang-chow	Pang-shwuy-hien	Coarse wash-gold.
	Chung-chow		Do.
	Kwei-chaou-foo	Wan-hien	Do. 30 *le* S.
	Sin-ting-foo	Ta-tsoh-hien	Gold.
	Lung-ngan-foo	Ping-woo-hien	Coarse wash-gold.
	Mei-chow		Do.
	Lu-chow		Do. in the Tsing-kiang river.
	Ya-chow		Do. in the Pih-kia-shui river.
	Maou-chow		Gold.
Che-kiang	Ning-po-foo		Gold at Kih-yü-shan.
	Yen-chow-foo	In all the district	Wash for gold.
	Choo-chow-foo	Lung-tseuen-hien	Light-coloured gold.
	Do.	Sung-yang-hien	Do.
Fuh-kien	Foo-chow-foo		Coarse gold.
	Formosa	Fung-shan-hien	Gold E. at Kin-shan.
Kiang-si	Nan-chang-foo	Fung-sin-hien	Gold-sand.
	Jaou-chow-foo	Po-yang-hien	Gold at Hwang-king-tsih.
	Fu-chow-foo	Ling-tse-hien	Gold 40 *le* W.
	Kan-chow-foo	Shin-kin-hien	Gold.
Kwang-tung	Shaou-chow-foo	Ying-teh-hien	Do.
	Hwuy-chow-foo	Ho-yuen-hien	Do. at Lan-tien-ta.
	Shaou-king-foo	Kae-kien-hien	Do. Kin-tsung.
	Do.	Kwang-ning-hien	Do Kin-kung.
Hoo-nan	Chang-sha-foo		Do.
	Hăng-chow-foo		Do.
	Yuen-chow-foo		Do.
	Chang-teh-foo		Do.
	Chin-chow		Do.
	Tsing-chow		Do.
	Yo-chow-foo		Do.
Kwang-si	Liu-chow-foo	Yung-hien	Do.
	Do.	Lae-ping-hien	Do.
	Sze-ngan-foo	Pin-chow	Do.
	Do.	Tsien-kiang-hien	Do.
	Do.	Shang-ling-hien	Do.
	Ping-lŏ-foo	Ping-lŏ-hien	Do.
	Woo-chaou-foo	Hwae-tsih-hien	Wash-gold in river at Kin-ngoh-shan, 70 *le* W.
	Sin-chaou-foo	Kwei-hien	Gold.
	Nan-ning-foo	Hwang-chow	Gold-mines.
Kwei-chow	Tung-jen-foo		Gold-sand washings 100 *le* W. in the Sung-che river, and 140 *le* W. in the Ti-chi river.
	Tsun-e-foo	Tung-tsz-hien	Gold.
Yun-nan	Tsuh-hiung-foo	Yaou-chow	Coarse gold in the upper Ta-yaou river.
	Do.	Tsuh-hiung-hien	Gold in the Yen-shan mount.
	Li-kiang-foo		Gold washed in many places in the Kin-sha-kiang for a distance of 500 *le*.
	Yung-chang foo		Gold-mines in the Chang-pan-shan.
	Do.		Gold-washings in the Lant-san river.
	Tung-chuen-foo		„ in the Kin-sha-kiang.
	Yung-pih-ting		Gold.

According to Murray and Crawford (1836), gold is collected in the sands of the rivers in Yunnan and Sze-chuen [Se-tchuen, &c.], and copious mines of it are said to exist in these provinces, and in Hoonan [Hou-kwang]. Williams (1848) adds that it comes especially from the upper branch of the Yangtsz-kiang, called Kinsha-kiang ("golden sanded river") from this product.

The largest amount is said by Davis to come from Likiang-fu, near that river, and from Yungchang-fu on the borders of Burma.

Barton (1862) noticed along the shingly flats and islands in the Yangtsz-kiang above Kweichow, that the natives were washing for gold; and at one part the river is called the "golden reach." About 2 miles below Wan is one of these extensive flats, which was marked out by the Government into lots, and let out to the washers, who were in great numbers.

Blakiston (1862) came to one of these shingle beds a few miles above Siau-kiang, in the same river, where a number of people were at work turning up the sand and stones, and washing it in rockers. From this point upwards, for a considerable distance above Wan, he often came on large parties of people similarly occupied. Five men are employed at each rocker; the labour of digging and carrying the gravel being divided between two, another carries water to a trough alongside of the one who rocks and washes, and the remaining man collects the washed sand and removes the shingle. The cradle or rocker is simply a shallow wicker basket resting on a frame, which has a joint, and allows of an oscillating motion to and from the washer, who, as each man arrives from the digging—which is usually but 4 or 5 yd. distant, and deposits his load in the cradle, pours water on it, then rocks away, pours more water, and rocks again, until all the sandy particles are washed from the shingle, which is thrown away. The sand and the gold it contains, which by the way is in extremely small particles, run down a wooden inclined plane. The gold is subsequently smelted out; but the yield is so small that only the very lowest coolies care to work at this laborious employment. The number of people employed during the low-water season at this work must be considerable. The Chinese believe that the "dust" is washed from the mountains of Thibet; and the Yangtsz-kiang above is known as the Kinsha-kiang ["river of gold sand"], while at its junction with the waters from Tung-ting Lake, much lower down, it is called the Kin-ho ["gold river"].

After leaving Chung-king, he noticed many places where the shingle beds had been washed for gold; and a friend discovered in the British Museum a record that a M. Fage, a missionary, mentions that 3 days after leaving the Kinsha-kiang, he came on the "Lou-tsze" Kiang, which discharges itself into the sea to the S.W., on the banks of which he found numerous gold-washings.

Williamson (1867) says that gold is found in the sands of almost all the streams in the eastern portion of Shantung; it is found in all the rivulets around Hai-yang. The following places are very noted. Kiendien, 70 *le* (about 20 miles) S.E. from Lai-chow, in 37° 12′ N. and 120° E., and 95 *le* (about 27 miles) N.E. of Ping-tu; the quartz here is very rich, as well as the sand from it. Williamson was told that a tea-cup full of ground quartz would sometimes yield 2 oz. of gold, and that 100 *catties* (133⅓ lb.) of sand was worth about 1000 *cash* (5*s.* 10*d.*); he was also informed that a man from Shen-si with 300 followers, many years ago, cleared in 2 months 50,000 oz., after paying all expenses. Another place is Ku-hien, about 18 miles W. by S. from Chefoo. Gold is procured in the streams which flow from the Lau-sze-shan. He passed several old gold-washings on the banks of the river which flows past the town. A third place is Kow-tew, near Ning-hai, 60 *le* (16½ miles) S.E. of Chefoo. He was told that the gold-washers in the district of Tsi-hya made an average of a dollar a day in 1866.

Cooper (1870) says the natives collect gold, both by washing the sands of the Lantsau-kiang, and by mining in the hill-sides.

Markham (1870) observes that in the streams and gorges of the Tsi-hya valley, near the seaport of Chefoo, Shantung, after heavy rains, gold is found in considerable quantities, and finds a ready market in Lai-yang. The Chinese are allowed to wash for gold, but are restricted from digging, or mining in any way; from the quantity obtained from these washings, it is presumable that the precious metal abounds in the province. He saw large nuggets which had been picked up.

Cooper (1871) alludes to the Mooquor chief showing one of his gold-mines. A number of people were hard at work: some bringing the auriferous earth from the horizontal shafts in the side of the hills; others washing it in long troughs, made of hollowed trees, into which a constant supply of water flowed from a little stream. The gold-mines, the chief informed Cooper, were very rich; indeed, "the country lying between Atenze and Weisee may be called the gold-field of China."

Col. Yule (1875) refers to Martini's statement as to the large quantities of gold derived from the Kinsha-kiang, which he identifies with the river Brius of Marco Polo. This latter asserts that in Carajan [Yunnan] "gold-dust is found in great quantities; that is to say, in the rivers and lakes, whilst in the mountains gold is also found in pieces of larger size. Gold is indeed so abundant that they give 1 *saggio* of gold for only 6 of the same weight in silver." Martini says that abundance of gold in Yunnan is proverbial in China, so that if a man lives very extravagantly, they ask if his father is governor of Yunnan.

Consul Adkins (1877), at Newchwang, gives an account of the valley of Chia-t'i-kou, some 30 miles long, in which there are rich diggings about 5 or 6 days' journey E. by S. from Kirin and Newchwang. The veins of quartz in the hill-sides are very numerous. The quartz, when dug, is roasted, then crushed, and then washed on a cradle or "slip"; and so rude and imperfect is the operation that it usually pays to wash the quartz 2 or 3 times. The quantity of gold found in a ton of quartz varies; but a Chinese miner, who showed the consul a slab of quartz brought from these diggings, assured him that less than $230 (47*l.* 18*s.* 4*d.*) worth of gold per ton is considered a poor yield. The miners in this locality are said to be a lawless set, and to have a very peculiar social organization. A man named the Han pays an annual tribute of 20,000 *taels* (5833*l.*) to the Chinese Government, and governs absolutely within the limits of his concession; and no official writ runs there without his permission. He has an armed following, and a number of miners and workmen are in his pay. Those who are not in his employ pay a royalty for permission to mine. The community under his rule is said to number about 1000, and is principally Chinese; but a number of Coreans have recently found their way into the territory, and are working with considerable success.

Capt. Gill (1880) noticed a couple of men washing for gold in the river bed about 5 miles below Shui-ching-p'u; and again in the bed of a stream about 600 ft. below Mount Tang-go-la. The washers sometimes get $\frac{2}{100}$ or $\frac{3}{100}$ *tael* per day only, sometimes $\frac{2}{10}$ to $\frac{3}{10}$ per day, and now and then a large nugget. He was told that the gold was not in the fine particles in which it is found in the Chin-sha, but in nuggets. This place is called Zu-gunda.

Consul Baber (1882) noticed that gold was washed above Lu-ting bridge, in the manner described by Capt. Blakiston on the Upper Yangtsz-kiang. It is also found in nuggets, occasionally of large size, in the border country. At the turn where the highway to Ta-chien-lu leaves the T'ung, i. e. at Wa-ssŭ-kou, gold borings driven into the rock may be seen on the further bank He could not approach the place; but the gold was offered him for sale in the shape of pills of clay, full of minute scales of the precious metal. Quite lately, gold has been discovered close to Ta-chien-lu, and the rush of diggers has caused a good deal of embarrassment to the authorities. North of Wa-ssŭ-kou, the T'ung is called Chin-ch'uan [" gold stream "] a term which is also applied to the district which it drains. It is unknown to Europeans. Alluding to the river which Marco Polo calls Brius, Baber identifies it with the "Upper Yangtzu [Yangtsz-kiang]; its local name is Chin-ho [" gold river"]; the name "Chin-sha-chiang [" golden sand river"] should in strictness be confined to the Thibetan course of the stream."

This section may be concluded with the following valuable remarks by Henry F. Holt, the learned Librarian of the Royal Asiatic Society, who was so good as to prepare them specially for the present work :—

" HENRY F. HOLT'S NOTES ON GOLD IN CHINA.

"At Burga Bulak-tae, on the western confines of Uroumtsi (Chinese Tieh-hwa) there is an abyss about 13½ geographical miles in circumference, covered with hot ashes, and a crust of sulphur and salt. So pestiferous are its exhalations that not a bird can fly over it, nor any human being or animal approach it with impunity. Not far from this place are the celebrated productive mountains that yield a large quantity of gold. They are situated in Suyhae district, some also in the barbarous regions of Urkitla and Usoo, and are worked to a considerable extent by the natives. Over each 50 of them, the Government appoints a head man, who becomes responsible for the payment of 3 per cent. of the pure metal to the State. All the proceeds must be cast into bars by certain *shroffs*, who affix their stamp to them to attest their purity. Ingots that have not received this mark are liable to confiscation. To prevent smuggling, Government appoints military posts near all the mines. The gold is paid into the hands of inspectors, who keep a very accurate account, and forward it to the capital as often as an official of high degree proceeds to Peking. The average annual amount is not stated, for the bullion is paid into the Imperial Exchequer, and not carried to public account. The works are very extensive, and above 30,000 miners find constant employment.

"There are other mines in the Tunhwang district. Government does not allow more than 2000 men to work them, and appoints overseers to control the miners, and to take care that the 3 per cent. is properly paid into the Treasury. The very minute regulations regarding the mining operations here, sufficiently prove that smuggling is extensively carried on, and that the number of persons actually engaged in mining exceeds perhaps three times the limits officially fixed. All the proceeds of the revenue are paid into the hands of the administrators of the Imperial Treasury.

"In one of the most desert parts of Shensi province, on the northern frontiers, at the Hopootă and Hala mountains, much gold-dust is found. Government does not interfere in this enterprise, but exacts a security from the head man of every 50 mines, to pay regularly of every *tael* (1⅓ oz.) of pure gold, 23 per cent. into the public treasury, and 3 per cent. additional for contingencies. Though some of these exactions are regularly discharged, a great part of the precious metal, which is obtained by uncommon dexterity, is smuggled and privately sold.

"The celebrated Yangtsz-kiang river, which flows through Yunnan under the name of the Kinsha-kiang [the river of golden sand], finds employment for hundreds of thousands of natives, who wash for gold. Government, in order to levy a tax on this, has divided the river into small districts, each of which pays a monthly rent of 1 *mace* (7*d.*) in gold, and 7 *taels* 2 *mace* 6 *candareens* (42*s.* 4*d.*) per annum as a fee. The works are principally at Yangpih, a district in the north-west, inhabited by aboriginal tribes, the most persevering workers of the mines under the direction of the Chinese. As the exactions on the part of the Government are by no means heavy, the enterprise thrives and the labour is remunerative.

"The mines at Ho-king (26° 32′ N., 100° 22′ E.), Pihya, and Pootsaou are celebrated for their productiveness. Government grants licenses to master miners, for which they pay every month 2 *mace* 5 *candareens* (1*s.* 6½*d.*) in gold, with an annual rent of 7 *taels* 2 *candareens* (40*s.* 11½*d.*), and, during an intercalary year, 1 *tael* 2 *candareens* (5*s.* 11½*d.*) in addition. The large number of people employed here proves the importance of these mines.

"In the south-west part of this province, on the frontiers of Cochin China, in the district of Kalhwa, the famous gold-mines of Ma-koo are situated, and not far from them are those of Manso. They are entirely in the possession of hardy mountaineers, who pay a trifling tax to the Chinese Government. The ore is found amongst the most frightful mountains, inaccessible to every one except the natives, who, with the agility of a chamois, ascend the highest cliffs and rarely miss their footing.

"Richer than any of the above mines are those in Kweichow province, at Kingshe, within the district of Sze-nan-foo, on the frontiers of Szechuen province, a region inhabited by Meaou-tze tribes. They pay 40 per cent. of the nett produce and 3 per cent. for fees. The gold obtained here is of the best description, but to get at it great dangers have to be encountered, and the privations of the miners in their perilous pursuit exceed all belief. The mountaineers are the more numerous workmen. The country all around is destitute of nearly every other production, so that the people, surrounded as they are by wealth, are extremely poor.

"Gold is found in several places in the north of China, Manchuria and Mongolia. Before the rebellion in Shensi, it was obtained from the sand of the rivers and streams of that province, especially in the neighbourhood of Lanchow. The Jesuit fathers tell us that an infinite number of persons made their livelihood by searching the sands of these rivers. Gold is also procured in considerable quantity in Mongolia, and in the centre and on the seaboard of Manchuria. Samples which have been brought from the neighbourhood of Poissiet very much resemble Australian gold.

"It is indeed astonishing to become aware of the universality of the knowledge of the existence of gold in northern China, and of the apathy with which it appears to be regarded. It is found in the sand of almost all the streams in the eastern portion of Shantung province after heavy rain. It is found in the rivulets in the neighbourhood of Hae-yang. But while thus widely distributed, there are several places which are pre-eminently distinguished for its production. Of these may be mentioned Kiea-dien 70 *le* (20 miles) S.E. from Lae-chow, in 37° 12′ N., 120° E., and 95 *le* (27 miles) N.E. of Pingtu. Marvellous stories relating to the richness of the quartz and of the sand are current among the people, which of course have to be taken 'cum grano.' It is said for instance that a teacup full of ground-down quartz would sometimes yield 2 oz. of gold, and that 100 *catties* of the sand is worth 1000 *cash*. It is also said that many years ago a man came from Shensi province with 300 followers, and that in 2 months he cleared 50,000 oz., after paying all expenses; and so on. Twelve or thirteen years ago a company of respectable men belonging to the neighbourhood made a proposal to the local authorities to work the mine, but 10,000 *taels* (2916*l*.) were demanded before the necessary permission would be accorded, and this led to the abandonment of the scheme.

"Another place famed as a market for gold-dust is Koohien, about 18 miles W. by S. from Chefoo, in Shantung. It is procured in the streams which flow from the Lansze hills. A third place deserving of mention is Kowtow, near Ninghai, 60 *le* (16½ miles) S.E. of Chefoo. The gold-washers in the adjacent district of Tse-hia make on an average about $1 (4*s*. 6*d*.) a day."

Before quitting the subject, it may be well to add that so long back as 1868 the Chinese Government issued very strict enactments against the admission of foreigners to work in the gold-washings and -mines, ostensibly for fear of dissensions arising between them and the natives.

COREA.—Oppert (1880) states that the natives' searching and digging for precious metals is strictly forbidden, and this prohibition is so rigorously kept up that transgressors are threatened with capital punishment; notwithstanding which, it cannot be altogether prevented, at least in those places where gold-dust is found, which is the case in nearly all the rivers of the central and southern provinces. Gold is found everywhere, all over the country, in quartz, and as dust in the river beds; the province of Pieng'an, nearest to China, is reported to have the richest gold-mines of all. The standard of the Corean gold is a very low one, however, it being of only half the fineness of Chinese gold, or barely 50 touch, as compared with Chinese 98 touch fine. Gold is one of the principal productions in the neighbourhood of the harbour of Gensan.

INDIA.—The subject of gold in India has been worked up with great care and research by Ball, and recently published in the volume treating of the economic branch of Indian geology. This will form the main source of the information given in the present section, but will be supplemented to a considerable extent by facts derived from private communications, and by consulting some few authors whose works were inaccessible to Ball, or have been published since he wrote.

General remarks.—Ball introduces the subject with some general remarks which clearly show his opinion of the regenerated ancient industry—the getting of gold in India; and though his views must be regarded as illustrating the pessimist view of the matter, they exhibit throughout a tone of caution which is eminently appropriate to the case, and deserves greater heed than has hitherto been paid to it. A summary of his remarks will here suffice.

Although, he observes, the values of all mineral deposits are apt to be overrated, both by the general public and by persons possessing a "little knowledge" of the subject, there is perhaps not one of them with regard to which more unsound and fallacious arguments are applied than to gold.

It is commonly said of countries where gold-bearing sands are found that there must necessarily be some source where the gold occurs in abundance. By experience, no less than by general considerations, the falsity of this conclusion has been repeatedly demonstrated; but it continues to be asserted to this day.

It must be borne in mind, however, that the subaerial degradation and erosion of the earth's surface by the action of the elements has been going on, in the same manner as at present, for an enormously long period of time. Huge valleys have thus been scooped out and vast masses of materials have been carried down by streams, and it cannot be denied that the sifting action of such streams would tend to concentrate the heaviest particles in the nooks and crannies and to carry away the lighter ones: hence the apparent abundance of gold in a virgin stream. The gold may have originally occurred very sparsely disseminated through an enormous mass of materials; but, by the concentrating process which has been so long in operation, nature has done the heaviest part of the work, which the gold-washer completes. He soon finds out that the amount of gold brought down in a single year gives him insignificant returns, and, in time, an area becomes practically exhausted as regards its alluvial gold; though in a country like India, where a man can live for so small a sum, it is possible to derive a subsistence, such as it is, from the washings of a few rivers year after year in succession.

The idea prevalent among gold-washers that, after a rest, old tailings become again productive in consequence of the growth of the gold, is explained by the fact that, under the influence of the atmosphere, decomposition and disintegration of enveloping minerals and hard crusts take place, whereby the gold is released from its concealment, and appears, and may be collected in the later washings.

The ultimate derivation of most of the gold of Peninsular India is doubtless from the quartz reefs, which occur traversing the metamorphic and sub-metamorphic series of rocks; but there is evidence to show that in some parts of the country, gold occurs in certain chloritic schists and quartzites, and possibly also in some forms of gneiss, independently of quartz veins. As to the relative productiveness of the reefs in the different groups or series of metamorphosed rocks, the imperfect evidence which at present exists is somewhat conflicting. The truth of the matter probably is that there is no rule applicable to the whole of the country. What may be true in Western Bengal—namely, that in so far as the amount of alluvial gold affords a safe guide, the general productiveness of the sub-metamorphic to the metamorphic rocks is as 2·5 or 3 to 1—is not necessarily true of other areas.

The presence of gold either as an original deposit or as a detrital product from the older rocks, has not as yet been proved in any member of the great Vindhyan formation. But in the next succeeding formation, several of the groups included in the Gondwana system are believed to contain detrital gold; of these, the evidence seems clearest in the case of the Talchir. It is almost certain, however, that the gold obtained in the Godavari and in its tributary near Godalore or Mungapet is derived from rocks of Kamthi age; and the gold of the Ouli river in Talchir in Orissa is derived from sandstones, but whether from those of the Barakar or the Kamthi groups is not certainly known, as both occur in the river section. It is of course natural that the sedimentary rocks which first filled the previously existing hollows and basins should contain gold, as well as the other materials derived from the degradation of the older metamorphic rocks; but gold is also probably present, though its existence has not yet been proved, in some of the still younger groups.

In so far as Peninsular India is concerned, the only other sources of gold are the recent and sub-recent deposits which rest on the metamorphic and sub-metamorphic rocks. Passing to the extra-peninsular regions, evidences of the existence of gold in rocks of several different periods are met with. In Ladak, certain quartz reefs which traverse rocks of the Carboniferous period are almost certain to be gold-bearing, as particular streams which rise within their limits contain auriferous sands. In Kandahar (see p. 270), gold occurs in rocks of Cretaceous age; here the deposit is an original one, and is connected with the intrusion of trap. Lastly, all along the foot of the Himálayas, from west to east, from Afghanistan to the frontiers of Assam and Burma, the Tertiary rocks which flank the bases of the hills, and which occur also in the Salt-range and in Assam, south of the Brahmaputra, are more or less auriferous. But this gold is all detrital, and was no doubt, in the first instance, derived from the crystalline metamorphic rocks of the higher ranges, which are otherwise known to contain gold. Although it is not inconceivable that exceptionally rich leads might occur in some places among the Siwalik sandstones, the project to search these rocks for productive reefs, of which something has been heard from time to time, could never have emanated from any one possessing the slightest knowledge of the nature of these deposits.

Perhaps the most interesting general account of the gold-mines of Southern India is that given by Mervyn Smyth. Alluding to the extent of the auriferous region of the Wynaad, he quotes Brough Smyth that "gold has been found in the south, near Eddacurra; on the north, near Nellacottah; on the west, near Vyteri; and on the east, as far as Bolingbroke, that is to say, over an area of more than 500 square miles." Of this area, native workings have been confined to Devala and its vicinity, a mere fraction of the country indicated; and even here the mines are of no magnitude, the deepest shaft being 70 ft. and the longest adit 126 ft.; and yet it is from such workings as these, within these narrow limits, we are asked to believe that such enormous quantities of gold as the following were obtained:—B.C. 1000: gold brought to Solomon by way of the Red Sea—3,330,000 lb.; A.D. 1294: ransom paid to Alau'a din, general of Jalalu'a din Khilgy, Emperor of Delhi, by the Rajah of Deoghar—17,500 lb. of gold; A.D. 1310: part of spoil of Devara Samuda (Halebid, Mysore) presented by Malik Kafur, to the Emperor of Delhi—2,400,000 lb. of gold; A.D. 1309: accumulations of Kales Dewar, Rajah of Mabar—1200 crores of gold = 1200 millions sterling, or 90,800,000 lb. of gold. That India may have produced this enormous quantity of gold is not improbable; but what we may well doubt is that all this wealth could have been derived from the Wynaad. Another point which goes to prove that the Wynaad could not have been the locality from which all this gold was obtained, is the singular absence of ruins of cities, temples, &c., and the presence of primæval forests of vast extent. One would imagine that where such immense wealth came from there would be indications of its influence, in the shape of great cities, temples, tanks, cultivation, and other signs of civilization.

The question that suggests itself is, if we are not to look to the Wynaad as the spot from whence this large quantity of gold was derived, where else are we to look? It is thought that all the necessary requirements are satisfied in an examination of the country forming a great triangle, whose sides may be indicated by the Eastern Ghauts, the river Kistna, and the Western Ghauts, and this country was known as Mysore at the death of Hyder Ali in A.D. 1782—a region whose geological aspect is similar to that of the gold-bearing regions of America and Australia. Eastwick, in an article in the *Gentleman's Magazine* for January 1880, mentions as one of the facts illustrative of the abundance of gold in Southern India, part of the spoil of Dwarasamudra, amounting to 2,400,000 lb., presented to the Emperor of Delhi, by Kafur, his successful general. The ruins of the city are to be seen in the vicinity of Halebid, in the Hassan district, Mysore. It is said to have been destroyed shortly after its capture by Kafur, by another of the ruthless Mahomedan invaders. The splendid temples still in existence speak of the great wealth of this place. Of the wealth derived from India by Solomon, it will be sufficient to say that many of the incidents recounted in the Ramayana, B.C. 1300, show that Mysore was at that time in a flourishing state. Among great cities of more recent date may be mentioned Ikkeri, Shemoga district (A.D. 1640), where gold pagodas and fanams were coined, many of which are still to be seen in the Mysore country; Bednur, or Nagur, at the capture of which place Hyder was said to have obtained 12 millions sterling. Here he established a mint, where gold coins—Haidari pagodas—were struck in his name. Vijayanagar (A.D. 1565) is identified with Hampe in the Bellary district.

Abdul Razzak, who visited it in 1441 as ambassador from the Court of Persia, speaking of its wealth, says—"In the King's treasury are chambers with excavations in them filled with molten gold, forming one mass. All the inhabitants of the country, whether high or low, even down to the artificers in the bazaar, wear jewels and gilt ornaments in their ears and around their necks, arms, waists, and fingers." It will be presently shown that all these cities were situated in or near districts known to be auriferous in the present day, and where may be seen ruins of mines of great extent. Of the N. and S. Ponaar (*pon*—gold, *aar*—river), it will be sufficient to mention the villages of Nulloor and Coondoor, on the former, and Utchalam and Poonpillay in the Salem district, on the latter, where gold-washing is carried on to the present day.

On the western coast, gold is found in the Gungavelly and Gairsoppa rivers, N. Kanara, and in the Beypur river, in Malabar. The auriferous reefs and old workings of the Wynaad have been reported on by Brough Smyth, while those of Kolar have had more than justice done them by such men as Munday, John Harris, and Vazie Simons, who have examined them on behalf of different companies. But it is not to these localities alone that auriferous reefs are confined: scattered all over the whole area are gold-bearing reefs and old mines, some of the latter of far greater extent than any to be found in the Wynaad or Kolar; and it is believed that no spot within the boundaries mentioned can be indicated, which is more than 50 miles from the nearest ancient working. Immediately south of Kolar is Baramahal, in the Madras Presidency, wrested from Tippoo in 1792. The greater portion of this district is made up of low hills, 1500 to 4000 ft. high. In the northern part of this district are the jaghires of Bagalur, Beriki, Sholagherry, and Kangundi, the mining rights of which have been purchased by several companies. About 10 miles west of the Coopum Railway Station is a singular looking conical hill, rising about 600 ft. above the surrounding country, and about 200 ft. above the remainder of the ridge, which runs north and south for about 15 miles. The top of this peak terminates in a boss, which overhangs on its south-west side and gives it a conspicuous appearance, so that it can be recognized from miles off. This hill is known as Mallapakondah, and is situated in the Kangundi jaghire, Salem district. Half-way up this hill, and on its southern face, is the entrance of an adit driven into the heart of the hill. It would appear that there were originally several of these drives at different levels, and the topmost is now filled in with the sinking of the roof, which can be traced for 100 yd. or so on the surface of the hill. The lower levels are still open, but obstructed here and there with great blocks of quartz and casing; with a little trouble and some inconvenience from the crowd of bats that come trooping out at this unusual intrusion, one can penetrate about 50 yd. The mine is called by the natives Gowd-shanie, and the inhabitants of the village of Purtheguttay, near the foot of the hill, are quite willing to lead the traveller to the mine, but they know nothing of its construction, or that gold can be obtained from it. A well-made road about 4 ft. wide, and paved the whole way (1½ mile) with large stones, leads to the mouth of the mine, and testifies to its wealth, as it must have paid well to have allowed of so expensive a pathway being constructed.

The quartz is highly ferruginous and dark-coloured, dense in the centre, and cavernous where it joins the casing; the latter is a kind of vitrified slate. The principal reef is about 10 ft. wide, and on either side are smaller reefs, from 2 ft. to 2 in. Sulphate of iron is apparent in some of these, and it is not difficult to collect flowers of sulphur in small quantities. No gold can be seen in the quartz by means of the naked eye, but a small piece of a few ounces, crushed and washed, gives innumerable grains of fine gold. It is not necessary to choose a particular piece of quartz; any bit from the débris lying about may be tested with good results. Two miles south, and on the same ridge, are two other mines within ½ mile of each other. The more northern, called Goolgunta, consists of three circular shafts sunk at the angles of a triangle, whose side is 50 ft. The shafts are connected by passages at about 40 ft. from surface, but it is impossible to tell their extreme depth, owing to the large quantities of water in them. Great heaps of débris testify to the amount of material that must have been excavated; ⅓ mile south-east is the Chigarulgunta mine, the entrance to which is by means of two shafts, each about 7 ft. wide, and 20 ft. long. The upper shaft is about 60 ft. deep, and at one end is a narrow manhole (just large enough for a small man to wriggle through), leading into the adjoining shaft, which is fully 100 ft. from surface. At the bottom of the deeper shaft are two adits running north-west and south-east along the strike of the reef. Great numbers of rock-pigeons have taken up their abode in these mines, and eggs innumerable and young pigeons are seen in the clefts of the rock. The great heap of excreta of these birds (not less than 20 ft. in height) testifies to the age of these mines. The whole of the rocks below are coated with chloride of ammonia (sal ammoniac) from the urine of the pigeons. The quartz is of a yellowish-white colour and pyritous, and is extremely hard, as is the casing; and it is wonderful to think how the natives could have cut through such dense stuff with their primitive appliances. One sample containing visible gold was chipped off from a leader 100 ft. from surface. Two miles farther south is another large mine, called Nundymoduk or Baswana. The natives say that this mine is of great extent, but the water with which it is nearly filled prevented its examination. The natives have a tradition that when the miners from seven adjacent villages were engaged picking away the quartz at the bottom of the mine, the water from the neighbouring river (S. Ponaar) found its way into the mine and drowned the workers, since which period it has been abandoned. There appears to be some truth in this statement, as when this mine was pumped dry, some three years ago, the skeletons of several human beings were found. This and the two last-mentioned mines are in the Beriki jaghire.

Numerous other mines exist in this and the adjoining jaghires of Sholagherry and Bagalur, and the whole country is cut up with numerous quartz reefs, and the gold is washed in all the streams during the monsoon. The whole of this country bears marks of advanced civilization at an early date. At present it is a wilderness of thorny shrubs with here and there small villages of from 40 to 50 houses. In the immediate vicinity of the mines just mentioned are ruins of two large cities—Nungungowdah and Dauerkondanee. The ruins of the former cover several square miles, and the breached bund of an immense tank, 50 ft. high, and 1 mile long, and pitched throughout with large stones, testifies to its importance. In Dauerkondanee are still standing several temples, built throughout of finely chiselled stone, in good preservation. The elaborate and delicate carving of the cornices, the great size of the blocks used, speak of the lavish use of money. Numerous inscriptions in ancient Kanada line the basement of the inner temple. On the adjoining hill (Yale Kotay mulla—seven-fort hill) the remains of fortifications are to be seen, one above the other to the top of the hill. Within the topmost line of fortification is a large cave running some distance into the heart of the hill; and within this cave, tradition has it, the mint of Balla Raj was constructed. To this day, they say, when, after heavy rain, water rushes from the mouth of the cave, small gold coins are occasionally picked up. This locality, with its numerous antiquities, affords ample materials for the archæologist: 80 miles south from this place, we come to the mines worked by Tippoo, in the Kolegal taluq, Coimbatore district. These mines, as well as those in the adjacent taluq of Chamrajnuggar, Mysore territory, were filled in, it is said, by Tippoo, and the inhabitants of the neighbouring villages deported, to prevent intelligence of these workings reaching the ears of the English, under Lord Cornwallis, who invaded Mysore from this direction.

The mines in Chamrajnuggar are of great extent and of much antiquity, and it is from this region that all the gold said to be so common at Munipur is supposed to have been got. Land for mining purposes in Chamrajnuggar and Kolegal has been applied for by several English and Indian companies. Thirty miles to the W.S.W. are the Nilgiris, where are old workings of some extent at Nunjanaud, described by Brough Smyth in his report on the Wynaad. Farther west is the gold-field of the Wynaad and Malabar. Skirting north Wynaad is the Heggadevenkota taluq, Mysore territory, where gold is said to be found in the streams. Still farther north, in the Attikuppa taluq, is the gold-field of Chinnataghery, near Bellibetta. These mines are reputed to have been of great wealth, but to have been worked out. The famous temple of Melukote—the richest in Mysore—is said to have been built with the wealth derived from these mines; but at present a few washers are just able to earn a precarious livelihood by sifting the sands of the neighbouring streams during the monsoon. The late Maharajah of Mysore made an attempt to work these fields, and employed a set of native miners for about a month; but as no results were obtained, the attempt was abandoned. About 12 years ago, several samples were sent in from this locality by Col. Hill, of the Mysore Commission, with a request that they might be assayed and something be done to open these mines, of which about 54 exist at Bellibetta, if the result of the assay should be favourable; but nothing seems to have been done, the report was pigeon-holed, and the samples were sent to the local museum.

At present the land has been applied for by several European gentlemen, and the truth of the report of the exhaustion of its auriferous product will soon be tested. North, again, are the ruins of the once famous city of Dwarasamudra, now called Halebid (*hale*, old, *bedu*, houses). Allusion has already been made to the great wealth of this city in comparatively modern times; no less than 2,400,000 lb. of gold was paid to Kafur as a ransom, and it has often been a subject of inquiry as to where this vast quantity of the precious metal could have been obtained. An examination of the low slate hills to the west of Halebid, and so far north as Sakarapatam, will show that they are in places actually honeycombed with mines, some in good preservation, others filled with débris.

Every stream about these hills gives a small yield of gold, showing that their auriferous wealth is far from exhausted. In the adjoining taluq of Harnhalli, are numerous mines and old workings; and so common was this metal during the reign of the Hoysala Ballala kings, that a local tradition has it that the sculptors employed on the famous Halebid temple were paid in gold equal in quantity to the dust resulting from the tooling of those "marvellous elaborations of ornamental sculpture." There may be some truth in this tradition, as even the price alleged to be paid to the masons would not be too much for work that has called forth the following eulogium:—"Some of these are carved (on stone) with a minute elaboration of detail which can only be reproduced by photography, and may probably be considered as one of the most marvellous exhibitions of human labour to be found, even in the patient East." —(Fergusson's Architecture, p. 397.) These temples are computed to have cost 9,000,000*l.* sterling. About 70 miles due west from Halebid, and in the South Kanara district, are the celebrated diggings of Moondabetta, 7 miles south of Mudu Badari. Here, too, European enterprise has stepped in, and after one or two failures is now in a fair way of success. North-east from this are the Honnali fields in the Shemoga district. The richness of these fields may be judged from the following official communication from W. Hill, Deputy Commissioner of the Shemoga district, to the Commissioner of the Nagur division, dated respectively Nov. 16 and Dec. 16, 1878:—"The only place in the district where gold is to be found is a nulla near the village of Pulvanhulle in the Chattanhulle margin of the Honnali taluq. It appears that gold-dust was formerly obtained by washing the sand of the nulla. The right to do so used to be farmed out under the head Julgar, but this item of revenue was abolished in 1870. *Vide* Isthiar, dated Sept. 28, 1860, the amount of contract realized was—1857–58, 357 rs. 8 a.; 1858–59, 264 rs. Since then, 2 to 4 rs. weight is brought weekly to the market at Nyamti for sale by the Julgars (sifters)." "Since writing my letter, No. 763, of the 16th ult., on the gold washed out from the sand, or rather alluvium, of the Pulvanhulle stream, 3 miles south of Nyamti, I have the honour to report that I have been able to visit the spot and gather the following further particulars:—(2.) The number of men who gain a livelihood by washing the gold is about 20. Their number was formerly greater, but several have been attracted during the last 10 years to a hill called Bijari Gudda, near Karkal in South Kanara, where the finds are said to be greater and the work more remunerative. Work is carried on in the Pulvanhulle mostly in the rainy months, and regular workers are said to be able to earn as much as Rs. 50 (5*l.*) in the season. Once and again small nuggets are met with. The largest found was about 10 years ago—1 oz. 14 dwt. 6 gr. in weight; another more recently of 1 oz. 5 dwt. 17 gr.; and a third, accidentally to an outsider, of 1 oz. 1 dwt. 10 gr. in weight. The quantity of gold bought annually in Nyamti and the neighbourhood is said by the traders to be 1 lb. 11 oz. in weight, of the value of Rs. 800 (80*l.*). I beg to forward a small specimen of the gold, valued at Rs. 5 (to be obligingly returned if not bought for the Museum), also some black ferruginous sand with minute particles of gold (of the value of As. 3) such as is usually found by the washers. The diggings are not confined to the Pulvanhulle stream, but to all the minor streams flowing from the hills in the neighbourhood. One of the best is said to be the Surhona stream, near Devikopa, a little off the Kumsi Honnali road, about 3 miles north-west of Nyamti, and about the same distance from Pulvanhulle. The chief drawback to its being worked is the want of water. The Julgars (washers) informed me that they were well aware that gold was dug up from pits in Kanara, but they explained that it would be useless to attempt it here, as veins of gold were not found imbedded in the quartz. I forward specimens of the quartz, slaty rock, gravel, and hematite (ironstone) picked up by me at the heads of the streams from which the gold is washed down. They may be of assistance in enabling Brough Smyth, with the foregoing information, to judge whether it would be worth while to take the trouble of inspecting the locality. Evidently the prospects of finding richer veins in South Kanara are greater."

It is a noticeable fact in Indian policy that where a handicraft has been confined to a family, or set of families, for a lengthened period, the people who practise the calling are identified with it, and it becomes a caste distinction, as much as the well-known four great divisions of Brahmin, Kchetria, Veishya, and Sudra. The goldsmith is as much distinguished from the weaver as the Veishya from the Sudra, while the barber and shoemaker have but little in general beside their humanity. Now, in Mysore, is the well-known caste of Julgars (gold-washers), not very numerous at present, perhaps, yet well known to the commonest ryot, thus showing how general the calling must have been at one time.

They are found to be in some numbers in the vicinity of known auriferous localities throughout Mysore, and their presence is, in a measure, indicative of the richness of the reefs there found. One other fact which goes far to prove that gold was commonly found in the country is to be seen in the geographical nomenclature of the province. Scattered all over this area are rivers, hills, towns, villages, and even whole districts, whose names are made up of a prefix, meaning gold, and a distinguishing terminal. It is not to be expected that so important a mineral as gold would have escaped the attention of the various races who have at different periods conquered the country, and that it did not may be learned from the fact that there are Sanskrit, Tamil, and Kanada expressions, meaning gold, to designate places from whence this mineral was obtained. Thus the Sanskrit for gold is *suvarna* and *hemma*. So there are the rivers Suvarna-mukhi ("gold-face") in the Kolar district, and Suvarna-vati ("gold-feature") in Chamrajnuggar, and the village of Suvarna in the Honnali taluq, Shemoga; Hemavati, a tributary of the Cavery, and Hemagiri ("gold hill"), a large bund across this river in the Narsipur taluq. In Kanada, gold is *honna* and *chinna*, and we have Honnu-Hole, Honnali, Honnavalli, Honni Kambli, Bhatta Honavar, and Chinnagherri. In Tamil, we have Ponaar, Ponoor—*pon* being Tamil for gold.

The early classical writers all have references to Indian gold.

Strabo says (B. xv. c. i. § 30), "It is said that in the territory of Sopeithes there is a mountain composed of fossil salt, sufficient for the whole of India. Valuable mines also both of gold and silver are situated, it is said, not far off among other mountains, according to the testimony of Gorgus, the miner of Alexander. The Indians, unacquainted with mining and smelting, are ignorant of their own wealth." And (B. xv. c. i. § 34), "The Seres" (whose country and capital still preserve the name of Serhend) "make no use of gold nor silver, although they have mines of those metals." And (B. xv. c. i. § 44), "This writer" (Nearchus) "says that he saw skins of the myrmeces, or ants, which dig up gold, as large as the skins of leopards. Megasthenes, however, speaking of the myrmeces, says, among the Derdæ, a populous nation of the Indians living towards the east and among the mountains, there was a mountain plain of about 3000 stadia in circumference; that below this plain were mines containing gold, which the myrmeces, in size not less than foxes, dig up. They are excessively fleet, and subsist on what they catch. In winter they dig holes, and pile up the earth in heaps, like moles, at the mouth of the openings. . . . The gold-dust which they obtain requires little preparation by fire. The neighbouring people go after it by stealth, with beasts of burden; for if it is done openly, the myrmeces fight furiously, pursuing those that run away, and if they seize them, kill them and the beasts.

In order to prevent discovery, they place in various parts pieces of the flesh of wild beasts, and when the myrmeces are dispersed in various directions, they take away the gold-dust, and, not being acquainted with the mode of smelting it, dispose of it in its rude state at any price to merchants." And (B. xv. c. i. § 69), "They say, that some of the gold-digging myrmeces, ants, have wings; and that the rivers, like those of Iberia [Armenia] bring down gold-dust."

The tradition of the gold-digging ants is elucidated when dealing with Thibet (see p. 465).

Pliny also (B. xi. c. 36 § 31) alludes to "the horns of an Indian ant, suspended in the temple of Hercules, at Erythræ," which "have been looked upon as quite miraculous for their size. This ant excavates gold from holes, in a country in the north of India, the inhabitants of which are known as the Dardæ. It has the colour of a cat, and is in size as large as an Egyptian wolf. This gold, which it extracts in the winter, is taken by the Indians during the heats of summer, while the ants are compelled, by the excessive warmth, to hide themselves in their holes. Still, however, on being aroused by catching the scent of the Indians, they sally forth, and frequently tear them to pieces, though provided with the swiftest camels for the purpose of flight; so great is their fleetness, combined with their ferocity and their passion for gold."

Herodotus too makes frequent allusion to gold in India, indicating, as Rawlinson shows, that the whole of the region of Central Asia is in the highest degree auriferous. The ranges of the Hindoo-Koosh, Belur-Tagh, Mus-Tagh, and Altai all abound with this precious metal. In the Altai mountains, rude traces of ancient mining have been found. Bokhara and Thibet are especially renowned for their productiveness.

With regard to the ants, Herodotus has the following (Thalia, iii. 102–5):—"But there are other Indians, at no great distance from the city of Caspatyrus and the country of Pactyïca: they lie north of the rest of the Indians, and resemble closely, in their mode of life, the Bactrian people. These are the most warlike of the Indians, and are the people that are sent to procure the gold. In the vicinity of their territory the land is desert, being covered with sand: in these sandy tracts, accordingly, are found pismires of a size between the dog and the fox, specimens of which are seen in the menagerie of the Persian king, which have been caught, and imported from that country. These pismires, accordingly, burrow under ground; and, in excavating their habitations, throw up hillocks of sand, just the same and in the same manner, as the ants do in Hellas: they are likewise very similar to our own pismires: the sand that they throw up contains abundance of gold-dust. For the purpose of collecting this sand, therefore, the Indians are despatched to the desert. Each man harnesses together three camels;

two males fastened by traces on the off and near sides, and one female in the middle. The Indian rides the female camel, taking care to choose one that has lately dropped her young; for their female camels are not inferior in speed to the horse, and, besides, are stronger, and much better adapted to carry burthens. The Indians, therefore, provided each with a yoke of the above kind, proceed in quest of the gold; having arranged so, as to be able to commence collecting the sand at the time when the sun is most violent; because, during the parching heat, the pismires keep out of sight, under ground. When the Indians are come to the proper place, they fill with sand the leather-bags they have brought with them, and then retire at the most rapid pace they can: for the pismires, according to the Persians, detect the strangers by the smell, and forthwith enter upon a pursuit: the fleetness of the camels exceeds that of all other animals; for if the Indians did not get a good way a-head of the pismires, while those animals are collecting, not one of the men would escape. They add, that the male camels would not only flag, being inferior in velocity to the female, but would not pull together; while the female, mindful of the young she has left, does not allow the males to tarry behind. Such, according to the Persians, is the manner in which the Indians obtain most of their gold: the other sort of gold is not so abundant, and is dug up in the country."

Bengal.—Bankura district.—Gold is reported to have been obtained in very small quantities in the sands of the Dalkissur at Bankura, and the statement is not improbably correct. The absence of any record as to the occurrence of gold in the districts comprised in the Bhagulpur division is very remarkable, as *primâ facie* the character of the geology in several of them would justify suspicions of its presence.

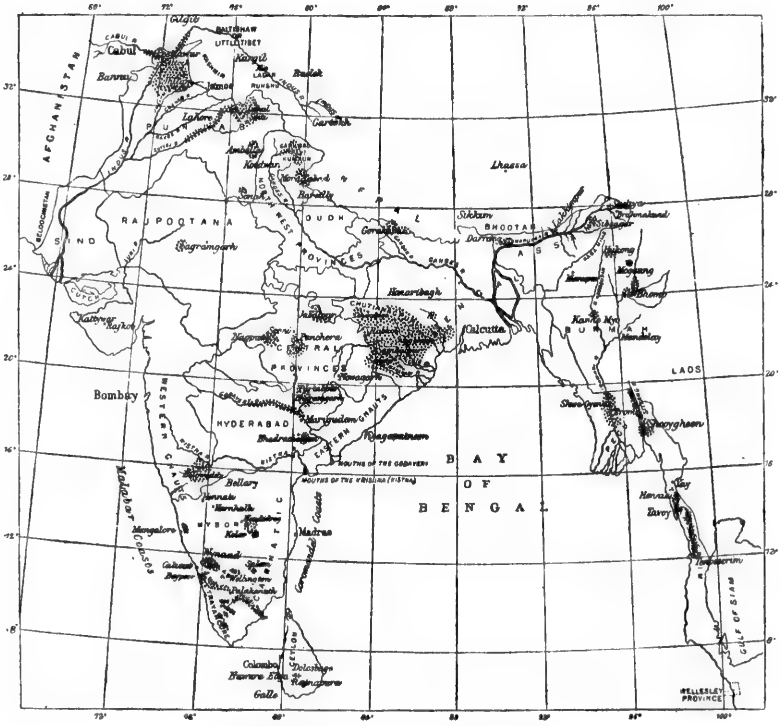
Midnapur district.—In the Midnapur district were 21 professional gold-washers according to the census returns. There is no published record of the actual spots where washing is practised; but they must be situated in the beds of the Kasai [Cossye] river and its tributaries. Throughout the greater part of the district, deposits of alluvium and laterite prevail; but the older crystalline and the sub-metamorphic rocks are exposed on the western frontier, which adjoins Manbhum and Singhbhum.

In the year 1855, a sample of gold-dust from Midnapur, which was forwarded by Lieut. W. D. Short, Executive Engineer, was examined by Piddington, who discovered in it some particles of a yellowish-white mineral, which was "malleable and tough, would not amalgamate with mercury, and was excessively difficult of solution in boiling *aqua regia*, though it certainly contained gold." He was inclined to believe that it might be a sulphuret of gold, an unknown mineral, but thought he detected a trace of platinum. Further and larger specimens which he applied for do not appear to have been received.

Bombay.—Within the limits of the Bombay Presidency, the districts of Belgaum, Dharwar, and Kaladgi in the Southern Mahratta Country, and the province of Kattywar, include all the localities wherein gold-bearing rocks are reported to exist.

Belgaum district.—Gold-dust within the limits of this district is reported to have been found in small quantities at or near the villages of Belowuddi, Byl Hongul, and Murgur. The rocks are chloritic schists and diorites, with thin veins and nests of quartz, reefs being rare, or concealed, if present, by surface soil.

FIG. 7.



SKETCH-MAP OF INDIAN GOLD-FIELDS.

Lieut. Aytoun obtained gold in the streams near Belowuddi, 15° 42′ 30″ N., 74° 59′ E., but it appears to occur in very small quantity. Foote failed to find any trace of gold there, and he was told that the Julgars had not been there for 10 years, so that it is evident they do not think much of its capabilities. The gold is supposed to have been derived from a quartz reef traversing the chloritic schists and diorite.

At Byl Hongul (15° 50′ N., 74° 59′ E.), or rather near two small villages, Chikop and Murkombi of the map, a few miles to the north, Aytoun obtained gold by washing, and the stream between these places was one ordinarily visited by the Julgars; but Foote was informed by the local officials that gold was unknown there. He mentions finding one quartz reef in which there were no sulphides or other likely indications of the presence of gold.

Foote was told by a native official that near the village of Murgur, 15° 53′ N., 75° E., Rs. 150 to 200 (15 to 20*l.*) worth was obtained by the Julgars. The rocks which are believed to contain the gold are said to be probably the same as those at Kappatgode. Gold is reported to occur also in the streams near Sogul, 4 miles S.E. of Murgur.

Dharwar district.—In this district, gold has been found at Chik Mulgund [Moolgoond], Surtur [Soortoor], Dambal [Damul], Dhoni, and the Hurti river near Guduk. All the available information regarding the auriferous tracts of Dharwar, Belgaum, and Kaladgi are contained in papers by Capt. Newbold, Lieut. Aytoun, and R. B. Foote of the Geological Survey. A letter by Scholt to the *Times of India*, also contains some information on the subject. Foote's paper, besides recording his own observations, gives a synopsis of what was written by the other authorities. A map of the neighbourhood of Dambal is published with this paper.

Foote considers that the metamorphic rocks of the known gold-bearing area belong to three distinct groups or series, each characterized by certain lithological peculiarities. He distinguishes them by the following local names, namely, Dhoni, Kappatgode, and Surtur. The Dhoni group consists of a hematitic schist, accompanied by chloritic, hornblendic, and micaceous schists. It also includes several beds of white and grey limestone, which may prove a valuable source of lime. Above this group comes the one called Kappatgode, the members of which form the Kappatgode Hill. They consist likewise of hematitic schists, with which are associated argillaceous schists, and the prevailing colour has changed from green to reddish-buff or mottled whitish. The third or Surtur group consists of hornblendic and chloritic schists, which are intimately associated with a massive diorite. Two other groups or series of granitic rocks in the neighbourhood, which do not appear to be auriferous, have had the names Gulduck and Mulgund conferred upon them, from the names of the villages near which they are found.

Quartz reefs occur in all these series, but it is only in the streams arising from the Surtur series, according to the natives, that auriferous sands occur; and the richest of all, that called Surtur, lies entirely within the area occupied by the chloritic schists and diorite. With few exceptions, the quartz reefs in the Surtur series at their outcrops have been broken up by gold-seekers. Most of these reefs run parallel to the bedding, but in the other series they often occur cutting across it.

In the Kappatgode series, is a reef called Hati Kati [Huttee Kuttee], in the débris from which, where it had been broken into by gold-seekers, Foote found a trace of visible gold. Pyrites altered into limonite, and thin veins of chlorite, occur in the quartz. Three rude sinkings and some shallow trenching indicate that mining by natives was carried on to some extent here. A shaft sunk on the east side of the reef is supposed to have been the work of a Gold Company which was started during the Bombay share mania. A similar shaft near the village of Dhoni (15° 17′ 30″ N., 75° 47′ E.) is known to have been the work of this Company. Australian nuggets are said to have done duty as samples of the results of these operations. The Hati Kati reef is 5 ft. thick; it dips 40° to 50° E., and the strike is N. by W. to S. by E.

Sulphides of the metals which commonly accompany gold were only found in the Hati Kati and two parallel reefs, but much of the quartz in the different reefs is what is called "mouse-eaten" by Australian miners—an indication of the former presence of foreign minerals. Samples of quartz selected by Foote were assayed in the laboratories at the Mint and the Geological Survey, but did not prove to contain gold. Even were there evidence of the presence of a greater amount of gold, the inaccessibility of this locality, and the scarcity of fuel and water, are serious drawbacks. There are only two or three families of gold-washers or Julgars in the neighbourhood. They use a sort of box made of light planks, which is 3 to 4 ft. long, 20 in. wide, and 9 in. deep, for the first and rough part of the washings. This box or trough corresponds to the Australian cradle. The sand is then removed to a dish or tray in which it is panned off. The iron-sand with gold is further washed in a half coconut-shell, and the final residue is treated with mercury. Scholt speaks in high terms of the care taken by these men, which he says surpasses that of the Chinese in Australia; but Foote considers the process wasteful, particularly in consequence of the shortness of the washing-box. The earnings of these men during the season varies from Rs. 5 to 50 (10*s.* to 5*l.*).

Scholt formed a very unfavourable, but apparently perfectly just, opinion as to the value of the alluvial deposits. The supply is very scanty, the stratum not exceeding 5 in. in depth, the bed-rock being apparent everywhere; 12 days' work at Surtur (15° 14′ 30″ N., 75° 43′ E.) yielded him only Rs. 2 to 3 (4 to 6*s.*) worth of gold.

Lieut. Aytoun, however, states that near Dambal (15° 17′ 30″ N., 75° 50′ E.) he sank a shaft in the alluvium to a depth of 7 ft., and found gold at all depths; and Le Souef, who had had Australian experience, also states that he obtained gold from shafts. He took a more favourable view of the place than Scholt, but his statements are somewhat vague.

In Capt. Newbold's time, the outturn from the Hurti, Surtur, and Dhoni streams was estimated at 200 oz. per annum; but, either in consequence of the yield of gold having diminished, or other more lucrative employment having become available to the Julgars, their numbers have much decreased, and the outturn is probably not now one-tenth of what it was. Capt. Newbold mentions that the Julgars understand the ancient Hindu method of purifying the gold and improving its touch; and says that gold used to be found at Chik Mulgund (14° 35′ N., 75° 27′ E.), in the Kor [Kod] taluq.

Kaladgi district.—Foote mentions a report, the accuracy of which he [illegible] to doubt, of auriferous sands being found in the streams at [illegible] (16° 3′ N., 75° 52′ E.).

Kathiawar.—Gold-dust in small quantities is said to be found in the Sourekha (*Soowurn seekta*, Sans. = gold-dust), a river which rises in the Girnar hills, but which is not marked on the maps. The Girnar hills have a height of 3666 ft., and are said to be formed of granite with quartz veins. It seems to be doubtful, however, whether there are any old crystalline rocks in these hills. So far as is known, the rocks are volcanic, of the Deccan trap period. Capt. McMurdo is said to have stated that gold was also found in the river Aji, which passes Rajkot.

Central Provinces.—Auriferous sands occur in most parts of the Central Provinces, where there are exposures of the older crystalline rocks. The census returns of 1872 gave the total number of persons whose trade is gold-washing at 215. Out of the four divisions under which the districts are classified, the Narbada division alone returns no gold-washers. The other divisions contribute as follows: Nagpur, 139; Jabalpur, 52; Chatisgarh, 12. The Upper Godavari district, which is classed separately, and one of the districts included in the Jabalpur division, have no gold-washers, the latter being Mandla—a fact easily connected with its geology. The rocks are chiefly trappean; but it may be that even in this district towards the south, where traversed by the Bunjar river, gold-bearing sands occur, since samples of gold from the bed of that river are now in the Nagpur Museum, but whether obtained within the limits of Mandla or Balaghat is not stated. As regards the Upper Godavari district, gold-washing does take place there, wherever the washers come from.

Chatisgarh division.—The census returns only give 10 persons as being employed as professional gold-washers in Sambalpur. This is not improbably an under-estimate. The head-quarters of the principal colony are at Jhunan, on the Mahanadi, about 9 miles N.W. of Sambalpur.

Most of the early accounts of Sambalpur diamonds refer also to the fact of the Mahanadi and several of its tributaries containing auriferous sands. Although the actual localities in the Sambalpur districts where gold-washing is carried on are numerous, Ball confines his remarks on the subject to two localities where gold-washing was witnessed by him. These are Sambalpur town on the Mahanadi, and the village of Tahud on the Ebe [Ib].

Close to Sambalpur town (21° 28′ N., 84° 2′ E.) the banks and bed of the river contain gold. In Col. Ouseley's time, it used to be found as far down as Sonpur. The various tributaries of the Mahanadi which traverse the metamorphic rocks are all probably more or less gold-bearing. The early writers did not recognize the probability of the gold and diamonds being derived from different sources. As both were found together in the bed of the Mahanadi, they were supposed to come from the same rocks. The diamonds are traceable back to the Lower Vindhyan rocks; while the gold, though possibly in part coming from the same, is chiefly derived from the metamorphics. At Jhunan, on the Mahanadi, there is a small colony of gold-washers, who travel to the different localities when the water falls after the rains. Fig. 8, after Ouseley, illustrates the gold-washer's art as prosecuted at Heera-Khoond [Híra-Khudá], an island in the Mahanadi, between Sambalpur and Sonpur.

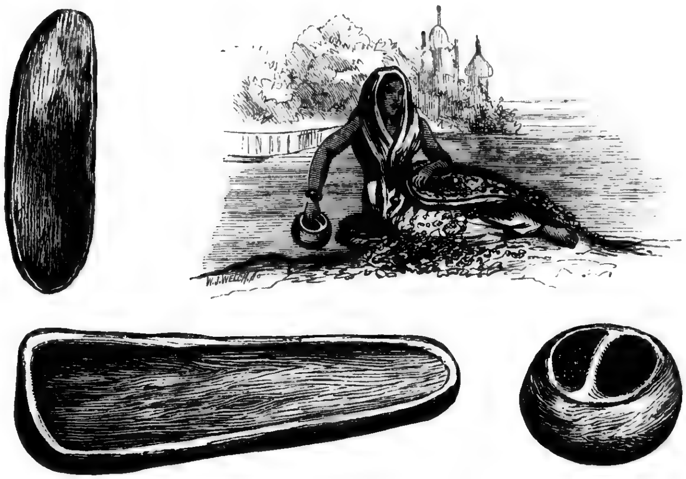
Near Tahud, on the Ebe river, a party of the above washers were seen encamped and at work by Ball. The spots where they were then washing were within the area occupied by rocks of Talchir age; but whether the gold had been proximately derived from these, or had been brought down from the neighbouring metamorphic area, it was impossible to decide. There is of course no *primâ facie* improbability in these Talchir rocks containing gold; on the contrary, the boulder bed, containing as it does such a large proportion of materials directly derived from the metamorphic rocks, might naturally be expected to include gold. The occurrence of gold in the sandstones of the Talchir field has already been mentioned, and similar cases will be found in reference to still younger deposits on future pages. In Australia, a conglomerate bed of Carboniferous age is known to be auriferous.

According to the census, there are but two gold-washers in the Bilaspur district. The only recorded locality where gold is known to occur is in the Jonk [Jong] river, near Sonakhan (21° 25′ N., 82° 38′ E.). Whether this place owes its name to the fact of there having been a gold-mine there is not known, but Capt. Wilkinson is the authority for saying that the Jonk river in this vicinity is auriferous. Although it is believed that Sonakhan itself is on the margin of the Lower Vindhyan rocks of the Chatisgarh basin, it is known that a considerable portion of the course of the Jonk south of Sonakhan is through metamorphic rocks. The sources of the river, however, are situated in the outlying tract of Lower Vindhyan rocks near Nowagarh.

There were 12 gold-washers in the Raipur district in 1872. It is not known in what parts their operations are principally carried on. Capt. Wilkinson states that gold is procurable in the Mahanadi at Rajoo. The only place of similar name on the Mahanadi is Rajim (20° 58′ N., 81° 56′ E.), which is situated on Lower Vindhyan rocks. It is possible that the gold may have reached the Mahanadi by its tributary the Pairi, which passes through metamorphic rocks 12 miles off in Nowagarh, though that would be rather far for it to travel.

In the Bhandara district are only 3 professional gold-washers. Gold-bearing sands occur in streams near Ambagarh (21° 26′ 30″ N., 79° 43′ 30″ E.) and Thirora. The Sonnala is mentioned also as gold-bearing; but as it does not appear on the maps, it may be one of the above. According to Wilkinson, the Maroo stream, in Amborah pargana, used to produce gold. As there was formerly a pargana called Ambagarh, it is probable that was the place meant. An unnamed tributary of the Wainganga, near Thirora (21° 24′ 30″ N., 79° 59′ E.), is said to contain auriferous sands.

FIG. 8.



GOLD-WASHING AT HEERA KHOOND.

In the Central Provinces Gazetteer, it is stated that the gold of the

Bhandara district is somewhat impure, only bringing Rs. 10 to 12 (20 to 24*s.*) per *tola* (180 gr.). Mercury is employed in separating the particles from the sand. The geology of Bhandara has not yet been fully ascertained; but the older metamorphic rocks are known to occur there, as also some sandstones, &c., of Lower Vindhyan age.

According to the census of 1872, there are only 6 professional gold-washers in the Chanda district. The search for gold is carried on, it is believed, in the eastern parts of the area, where metamorphic rocks prevail; but there are no published details as to the actual streams in which it is found.

The census return of 1872 gives the number of gold-washers living in the Balaghat district as being one only; but as gold is known to be washed in several places, it is probable that either the gold-washers of Nagpur, who are returned as numbering 103, annually migrate into Balaghat, or the actual washers have some other trade under which they have been classed. The auriferous streams of this district are situated in the Lanji (21° 30′ N., 80° 36′ E.) and Dhansua parganas. The rocks belong to the older metamorphic series. It is in two of the principal rivers of the Lanji pargana, namely, the Son and Deo, that the auriferous sands occur. As being gold-producing, these, especially the first (which probably owes its name to the fact), have long been known. Capt. Jenkins, Wilkinson, Hislop, and Hunter, all allude to the gold-sands near Lanji. And it is probably in consequence of the mention of it in the paper by the last-mentioned authorities that this locality has received more notice in European works than many others in India. There are gold-bearing sands also in some parts of the Bunjar river.

According to the Central Provinces Gazetteer, gold is obtained in the Sonabera stream, near the Panchera (21° 55′ N., 80° 16′ E.) ghat, in the Dhansua pargana. And other authorities state that gold is found in the Nahr river, in the neighbourhood of Mau (22° 13′ N., 80° 10′ E.).

Jabalpur district.—In this district were 14 professional gold-washers in 1872. Beyond this, and the fact that a sample of gold-dust said to be from Jabalpur was exhibited in the Indian Museum at South Kensington, there appears to be no record of the industry in this district.

Nagpur district.—The gold-washers of this district are more numerous than in any other in the Central Provinces. They number 103. It is probable that they carry on their operations chiefly in the adjoining districts, though some of them may find sufficient gold in the streams which traverse the metamorphic rocks of their own.

Sagar and Damoh districts.—In Sagar and Damoh are 19 and 7 gold-washers respectively, but it is not on record that gold is found in either district.

Seoni district.—Within the limits of this district, the sands of the

Parqudhur stream produce gold. It rises in the Konye hills, and falls into the Wainganga. The washers, of whom there are 12, consider it unlucky to earn more than 4 *annas* (*6d.*) a day.

Upper Godavari district.—Gold is said to be found in two localities in the bed of the Godavari river within the limits of this district, namely, near Bhadrachellum and at Marigudem [Mariguram].

Gold is washed for at the point where the Kinarsani river falls into the Godavari, on the Hyderabad side below Bhadrachellum (17° 40′ 30″ N., 80° 51′ 45″ E.). The rocks belong to the metamorphic or older crystalline series; but the Gondwana and Kadapah series are also represented close by.

The precious metal is washed for near the mouth of a small stream, which, coming from the Nizam's territory, falls into the Godavari opposite Marigudem (18° 17′ N., 80° 36′ 30″ E.), in the Naggar taluk. It is washed by people called Sonjharis ("gold-seekers"), not Sonjerries, as the name is sometimes written, who come periodically for the purpose. They begin operations in August or September, or whenever the river has fallen sufficiently to lay bare certain gravel banks, in which the gold occurs in minute grains. The gold is of superior quality to that of some other localities, being valued at Rs. 16 a *tola* (4*l.* 5*s.* 4*d.* an oz.). The rocks of this neighbourhood are Gondwanas belonging to the Kamthi group, so this gold has possibly a "doubly derivative" origin.

The Bastar state, which is attached to the Upper Godavari district, does not return any gold-washers in the census tables; but gold-washing is nevertheless carried on there, according to the Central Provinces Gazetteer, close to Pratappur [Partabpur], 19° 59′ 30″ N., 80° 47′ 30″ E., and at the junction of the Kutri [Kuthari] and Indravati rivers, i. e. near the village of Bharamgarh (19° 25′ N., 80° 39′ 30″ E.). The rocks of this portion of Bastar, it may be presumed, belong to the metamorphic series; but they have not as yet been examined by any geologist.

Wardha district.—In this district are 26 gold-washers, but there is no information available as to the precise localities where their operations are carried on.

Chutia Nagpur.—The Chutia Nagpur province includes the greater portion of the hilly region on the south-west frontier of Bengal. It is sub-divided into the following 4 British districts and 7 tributary states: Hazaribagh, Lohardaga, Manbhum, Singhbhum; Bonai, Chang Bhakar, Gangpur, Jashpur, Korea, Sirguja, and Udepur. From the characters of the rock found in each of these sub-divisions respectively, it is not improbable that gold occurs in all of them. Whether because it is less abundant in some, as is probable, or because it has never been properly searched for, the fact is certain that in others there is a greater attraction for the indigenous gold-seekers. Judged by this standard, which is the only one at present available, the richest tracts are situated in Manbhum, Singhbhum, Gangpur, Jashpur, and Udepur. There is no record of gold-washing being carried on in Chang Bhakar and Korea, and though gold is enumerated in Col. Ouseley's list of the products of Sirguja, it is not sought for there at present.

That these, or some of them, may yet be the scene of extensive operations, should the gold-mining in Southern India be successful, is very possible. The indications afforded by the alluvial deposits, of sources of gold existing in the rocks over several large areas, are perhaps quite as striking in their way as those which have led to the starting of the gold-mining industry in Southern India. Quartz or reef mining and crushing, however, can scarcely be said to have been tried in this area, but one solitary and not very extensive attempt having been made.

Bonai state.—Gold occurs and is washed for in the bed of the Brahmini, in Bonai (Bonai town, 21° 49′ N., 85° 1′ E.).

Gangpur state.—Within the limits of this state, gold-washing takes place in the bed of the Ebe and in those of some of its tributaries, more particularly in the Icha, as is indicated on the topographical survey map (22° 6′ 30″ N., 83° 55′ 30″ E.). This gold-bearing region adjoins those described in Jashpur and Udepur.

Surgeon Breton, in reference to the diamonds of this region, states that there were gold-mines in Gangpur and Jashpur just large enough for a man to descend, but of considerable extent below. In the Gangpur mine, an account of which was to be submitted, large pieces of pure gold were stated to have been found.

Hazaribagh district.—There does not appear to be any published record of gold having been found in this area, and properly speaking it ought not to be included in this list. But it is impossible not to believe, says Ball, that properly conducted operations would reveal its presence.

Jashpur state.—Col. Ouseley, when forwarding to the Government specimens of gold for assay, specifically mentions the village of Pharsabahal (22° 30′ N., 83° 55′ 33″ E.) as the locality whence they were derived. Other authorities are less precise, and indeed it is not quite clear whether portions of the following remarks refer to Jashpur or to Udepur.

Robinson (1849) speaks of shafts sunk to depths varying from 20 to 60 ft., and which are very close to one another, as the people are afraid to run galleries. In places, the ground resembles a gigantic rabbit-warren. Sometimes these old gold-bearing alluvial deposits crop out in the banks of the rivers. Besides washing for the gold in the ordinary wooden dishes, the people here arrange small water-courses before the rains, so as to catch the soil, in which a large proportion of gold is found; these are cleared out from time to time. Robinson writes that the late Raja of Jashpur, Ram Singh, had worked these mines with success; but owing to an accident in one of the shafts, by which a number of people lost their lives, operations ceased. His son, the then Raja, considered such work beneath his dignity. Robinson states that the Government at the next settlement (in 1850) intended to reserve the mineral rights to themselves, and he purposed applying for a lease, having no doubt that he would be able to get one for a good term of years, believing that these mines must pay splendidly.

Col. Dalton gives a very full account of the operations of the Jhoras or gold-washers of Jashpur. They find it more profitable to work the ancient deposits than to wash the sands of the river-beds. On both sides of the Ebe [Ib] river are tracts, at some distance from the banks, which are honeycombed with shafts sunk by successive generations of gold-seekers. These shafts are 10 to 30 ft. deep. The gold-bearing stratum is a layer of pebbles and fragments of quartz, which underlies red soil and vegetable humus. The stuff selected is of a dirty-drab or reddish colour, with occasional balls of decomposed felspar, which latter are regarded as the surest indication of the presence of gold. The decomposed granitic rock upon which this layer reposes is not generally washed, but Col. Dalton found that it was likewise auriferous, though in a less degree. Five shafts were in operation, one family to each, as the women and children assist, and each family has its *duin* or washing-dish. Accidents occasionally happen from the falling in of the shafts. The yield is very uncertain. The outturn from the 5 shafts obtained during 4 hours in Col. Dalton's presence would not have given more than ½ *anna* (¾*d.*) a head to those employed; but occasionally as much as ½ *tola* (90 gr.), or say Rs. 6 or 7 (12 to 14*s.*) worth of gold was obtained, according to the statements of the washers. No mercury was used, only the visible gold being saved. The particles were angular and not worn by attrition. As is commonly the case, these men were much indebted to the money-lenders, one being pointed out as owing Rs. 1000 (100*l.*).

From Pharsabahal, which is about 4 miles to the west of the Ebe, Col. Ouseley forwarded Rs. 11 weight of gold obtained from mines. Each village is bound to pay a certain weight of gold annually to the Raja, the heads of villages (Tikadars) buying from the Jhoras and paying for it in rice. The following reports on all the gold forwarded by Col. Ouseley were issued by the Mint Master, Col. W. N. Forbes:—

Quantity received.			Pure Contents.			Assay.	Intrinsic produce in *tolas* or new standard of gold *mohur*.
			Base alloys.	Silver.	Gold.		
				In 100 parts.			
1	2	6	4·047	8·062	87·891	3⅝ Ws.	95·888
0	8	0	..	7·031	92·969	1¼ Bt.	101·420
10	14	0	..	12·079	88·021	3½ Ws.	96·023

Mint Register. No.	Description.	Tale.	Weight in *tolas*.	Assay.	Assay produce in gold *mohurs*.
1847. 27th August, 545	A gold ingot from gold lumps and dust.	..	12 0 3	1⅛ Rs.	12 4 4
				Gold *mohurs*.	12 4 4
			12 0 3		or
				Co.'s Rs.	181 1 0

A few years ago, the Geological Survey Museum received from Col. Dalton a nugget which was obtained in Jashpur. It weighed on receipt 221·87 gr., and after cleaning, 199·6 gr. On assay, 13·562 gr. gave—

Gold chloride	12·836	= per cent.	Gold	94·64
Silver ,,	0·93		Silver	5·15
				99·79

The specific gravity was 15·24. The facts just given and those mentioned with reference to the states of Gangpur and Udepur, establish beyond a possibility of doubt the existence of an ancient alluvial gold-bearing deposit at intervals throughout a tract not far short of 2000 sq. miles in area. A considerable portion of this area is hilly, the rocks, so far as they are known, belonging to the metamorphic series; but since there is evidence that diamonds have been found in the Ebe river, it may be that an outlier of the Vindhyan series exists there. To the west and south of this highland tract are Gondwana rocks, including the coal-measures of the extensive Raigarh and Hingir field; outliers of the Deccan trap occur to the north-east. The principal rivers of this tract are the Mand and Ebe, with numerous tributaries. As there is always water in the Ebe, it is possible that some system of hydraulic mining might be applicable. Be that as it may, there cannot but be gold-bearing reefs from which all this gold has been derived.

Lohardaga district.—The Kanchi river, in Lohardaga, contains gold-bearing sands, which are derived probably from the same series of rocks as those included in the adjoining auriferous tract of Manbhum and Singhbhum. There are reports of gold having been found in the Sonai river, on the frontiers of the Palamow sub-division; but there are no published notices on the subject.

Manbhum district.—The localities where gold-bearing sands exist in Manbhum are very numerous; indeed in the southern half of the district are probably few streams in which gold, if searched for, would not be found.

By the systematic application of the operations of 2 gold-washers during a period of 3 months throughout this southern tract, Ball was enabled to define the area in which the gold was most abundant. This result not only agreed with the traditional knowledge possessed by the gold-washers, but it was found that the area in which gold was comparatively most abundant corresponded precisely with a tract in which a particular series of rocks occurred. These rocks, consisting chiefly of magnesian and mica-schists, slates, and quartzites, are included in the sub-metamorphic series; but although gold was most abundant in the superficial deposits within this area, those of the other portions of the district, where metamorphic rocks are alone present, did not prove quite barren: in fact, the largest piece of gold found, and which weighed 1·9 gr., was obtained in deposits derived from granitic gneiss rocks, near the village of Bhagmundi.

The boundary between these two formations has an east to west course, which roughly corresponds to the position of the 23° 5′ parallel of north latitude. Otherwise, and more nearly, it may be said to coincide with a line drawn from Simlapal on the east through Bara Bazaar to a point a little north of Ichagarh on the west, and so on into the Chutia Nagpur highlands. South of this line, the sub-metamorphic rocks almost exclusively prevail; and beyond the Manbhum frontiers they continue into Singhbhum and Lohardaga, where they maintain the same characters as regards their comparative richness in gold.

During the period above alluded to, a record was kept of the daily results and of the nature of the rocks in which the washings were made. The following abstract will suffice for comparison of the productiveness of the two formations.

SUB-METAMORPHIC ROCKS.

	Jan.	Feb.	March.	April.	Total.
Number of days on which washings were made	31	9	18	8	66.
Unsuccessful days ..	2	3	2	2	9 = 13·6 per cent.
Total gold in gr.	17·68	4·65	7·6	2·45	32·38.
Daily average ditto ..	0·57	0·516	0·4	0·3	Daily average for whole period $= \frac{32{\cdot}38}{66} = 0{\cdot}4$ gr.

METAMORPHIC ROCKS.

	Jan.	Feb.	March.	April.	Total.
Number of days on which washings were made	..	20	13	..	33.
Unsuccessful days ..	..	13	9	..	22 = 66 per cent.
Total gold in gr.	..	4·78	0·7	..	5·48.
Daily average ditto ..	..	0·23	0·05	..	Daily average for whole period $= \frac{5{\cdot}48}{33} = 0{\cdot}16$ gr.

Comparing the results by the number of successful days, it may be said that, for gold-producing, the sub-metamorphic rocks are to the metamorphics as (100 — 13·6 =) 86·4 to (100 — 66 =) 34, or 2·5 : 1; comparing by daily average, the proportions become 0·49 : 0·16, or 3 : 1. It may therefore be concluded that the sub-metamorphics are between 2½ and 3 times as productive of gold as the metamorphics; so that, as the gold-washers only find a subsistence from washing in the sub-metamorphic area, it is obvious that it would not pay them to work in that occupied by the metamorphics.

The actual amount of gold found was, it will be observed, very small, but the washers were often working on strange ground; and moreover they generally had to make a march of some miles before arriving at the scene of their operations, to which must be added also that their day's wage being certain, they generally contented themselves with a very limited amount of physical exertion.

The rivers which contain most gold in this area are the Subanarekha and its tributaries, the Karkari and Bamni, on the west of the area, and the Kasai and its tributaries, the Tutko and Kowari, on the east. Besides these, many of the streams in the neighbourhood of the Dalma hill range and in the Supur pargana might be enumerated.

In Supur, near the village of Namra (22° 54′ 30″ N., 86° 36′ E.), is an excavation supposed to have been a gold-mine, and it is so indicated on the map. The natives had some rather vague tradition of images of gold and silver bulls having been found there. Close by, gold is said to be found in scrapings from the roads, which are washed on a small scale by the Dhoras or Dokhras (= Jhoras) during the rains.

Gold-washing was tried by a European a few years ago on the Karkari river, near Ichagarh (23° 2′ 15″ N., 86° E.), the chief town of Patkum, but with what measure of success is not known. The process of gold-washing in practice in Manbhum is identical with that in Singhbhum, and need not, therefore, be separately described.

Singhbhum district.—In Singhbhum, gold occurs in very much the same manner as it does in Manbhum, the gold-bearing rocks being in unbroken connection throughout, and forming one united tract, with this difference, that in Singhbhum, so far as is certainly known, the sub-metamorphic rocks alone contain gold. These rocks surround a trap-traversed area of old granitic gneisses, which are probably older than the general metamorphic rocks of Manbhum; these latter are also represented in the western highlands of Singhbhum, where they, too, are possibly auriferous, but to a less extent than the sub-metamorphics.

In Manbhum, quartz reefs are not abundant in the sub-metamorphic rocks, and the washings seemed to point to the magnesian schists and certain bluish quartzites as being the sources of the gold. In Singhbhum, especially to the north and west of Chaibassa, quartz reefs are abundant in some earthy shales and slates, and it seems probable that they may prove to contain gold. The only nugget seen by Ball in Singhbhum was in a quartz matrix, and gold is said to have been obtained by quartz crushing at Landu.

The most noteworthy places where gold has been found in Singhbhum are Kamerara and the Kapargadi ghât in Dhalbhum, Landu in Seraikela, Asantoria in Kharsawan, Sonapet, Porahat, and Dhipa in Sarunda.

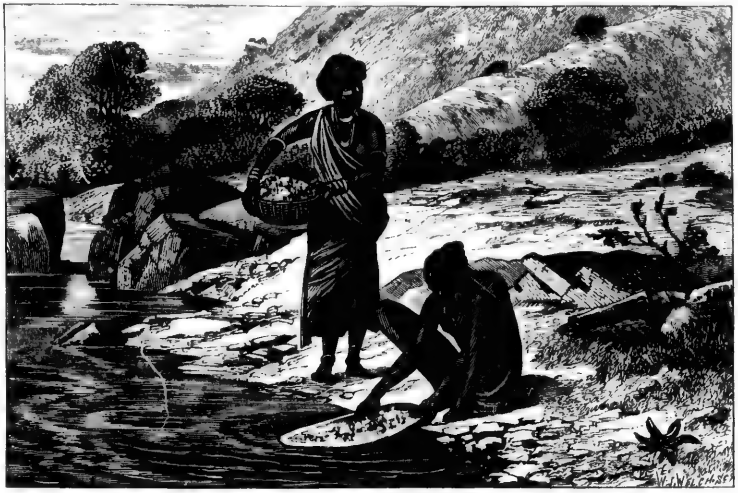
Before giving the known details regarding these localities, it may be well to describe the gold-washers and their operations, it being understood that they apply equally to those of Manbhum, and indeed, with local modifications, to all throughout the greater part of Peninsular India.

The class who more particularly follow the trade of gold-washing belong to a tribe of Gonds known as Jhoras, Dhoras, Dokras, Toras, or Jharas, according to locality. The name Jhora is said to be derived from *jhori*, a small stream, but Dhora may be derived from *dhona*, to wash. In the case of these people, both sexes engage in the pursuit; but the Ghasis, a local tribe of unknown origin, also occasionally wash for gold. Among them the men only, while among certain Kol or Munda tribes to the west of Singhbhum the women wash for gold, and their male relatives regard the work as an unworthy occupation for their sex. The methods employed by these different tribes appear to be identical in all essentials. Each occupies a distinct tract, and poaching on one another's favourite streams is not indulged in to any great extent.

The wooden dish used for washing measures on an average about 28 by 18 in. for the men, smaller ones being used by the women and children among the Jhoras. The dish is hollowed somewhat eccentrically to a maximum depth of 2½ in. A scraper formed of a flattened iron hook, set in a handle, is used to collect the auriferous sand and gravel which accumulates in the angles formed by the rocks in the beds of the streams. The dish when filled is placed in shallow water, and the operator working with his hands soon separates and throws aside all the coarser gravel and stones, while the agitation of the water serves to carry away all the mud and lighter portions. The dish is then balanced on the palm of the left hand, and oscillated to and fro with the right; this serves to throw off the greater portion of the remaining gravel, and the process is completed by a circular motion, which is communicated to the water in the hollow of the dish, by which even the smallest particles of foreign matter are separated, and the final result is a residue of black iron-sand in which the specks of gold are readily apparent; but as mercury is not employed in this part of the country, all the very small and invisible gold is lost. Fig. 9 will enable the reader to realize the appearance presented by these gold-washers when pursuing their trade, and Fig. 10 illustrates their apparatus.

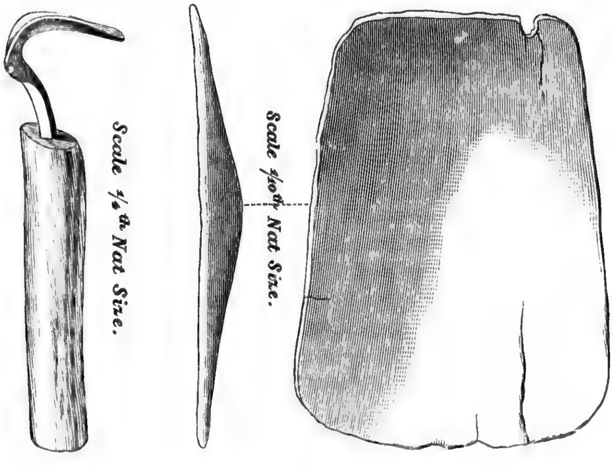
The daily earnings of the gold-washers are small, but might, no doubt, be increased, if it were not that they are always satisfied when

FIG. 9.



GOLD-WASHERS OF SINGHBHUM.

FIG. 10.



DISH AND SCRAPER USED IN SINGHBHUM.

enough gold has been found for procuring the day's subsistence. Col· Haughton (1854) stated that the Ghasis could always reckon on earning 3 to 4 *pice* (⅜ to ½*d.*) per diem; he was assured that a vigorous man often got as much as 12 *annas* (1*s.* 6*d.*), which, as the ordinary rate of field labour was about 1 *pice* (⅛*d.*), must be considered a very large sum. Robinson found, in a trial which he made at Rabkob, in Udepur, that men to whom he paid 1 *anna* (1½*d.*) could produce for him 3 to 4 *annas* (4½ to 6*d.*) worth of gold. Col. Dalton states that the washers themselves regard it as a very poor trade, simply yielding they say *pét bhur* ("bellyful"). Dr. Stœhr, in his paper on Singhbhum, recorded that he found the average daily earning to be about 25 *centimes* (2½*d.*). The men met with by Ball, stated that they could earn about 1 *anna* (1½*d.*) a day, and occasionally 3 to 4 *annas* (4½ to 6*d.*).

According to Col. Haughton, gold has been found in the bed of the Subanarekha at Kamerara (22° 15′ N., 86° 43′ 30″ E.), which is on the eastern margin of the rocky tract. He states his belief that the sands of this river continue to contain gold from thence to the sea. A nugget of gold shown to Ball when in Singhbhum was said to have been found close to the pass on the Midnapur road through the Kapargadi hills (22° 39′ N., 86° 23′ E.).

At Landu (22° 43′ 30″ N., 86° 15′ E.) and various other places, the copper ores were found to be auriferous to a small extent. A Mr. Emerson was employed by the Singhbhum Copper Company specially to investigate the gold resources of the country. He is said to have crushed a quantity of quartz, but there is no available record as to the results which he obtained.

At Asantoria [Assuntullea], 22° 44′ N., 85° 51′ E., gold is said by Col. Haughton to occur *in situ*; but it appears from the context that it is not to be understood that it was actually found in the rock there, but the locality being higher than the neighbourhood it was concluded that the matrix was close by. Dr. Stœhr mentions gold-washings at Baritopa, in the neighbourhood of Kharsawan.

Sonapet (22° 53′ N., 85° 44′ 30″ E.), or the "mother of gold," is the valley of the Sonai river to the north-west of Kharsawan. All writers refer to it as containing more gold than other parts of the district. Some years before 1854, nuggets were found there, according to Col. Haughton, but the finder never divulged the secret of the exact spot.

Col. Haughton alludes to a tradition of a regular gold-mine having been driven into the side of a hill in the jungles of Porahat (22° 36′ N., 85° 30′ E.). No trace of this mine remains at present. Gold-washing is carried on in the streams of Porahat by the women only of the Munda inhabitants.

In Sarunda, which is a hilly elevated tract in Singhbhum, intervening between the main area of Singhbhum and Gangpur, gold is washed for to some extent. Its occurrence in Anandapur and at Arabhanga is recorded by Col. Haughton. The latter name does not appear on the map, but close to the former, at Dhipa, gold-washing was witnessed by Ball.

The bed of the Koel river near Dhipa (22° 26′ N., 85° 15′ E.) yields a small amount of gold. The pay-dirt was scraped out from the nooks and crevices of some protruding rocks. Both sub-metamorphic and metamorphic rocks occur in this region. Col. Haughton on his map represents the beds of the Koel, Karo, Sunk, and the Brahmini, which is formed by the junction of the three, as gold-bearing, and they are so no doubt to some extent.

Udepur state.—Some of the early accounts of the washings and the assays of gold from them do not very clearly distinguish between those of Rabkob (25° 28′ 30″ N., 83° 17′ E.) and Jashpur, which are separated from one another by about 40 miles.

Col. Ouseley was the first to call attention to these washings, which he did in a report to Government, dated 1847; there were then only three families of gold-washers at Rabkob, and at the localities mentioned below there were no resident washers, and the gold was said to be of inferior quality to that from Rabkob. It was sold at Rs. 10 to 12 (20 to 24*s.*) a *tola* (180 gr.). Although these workings are spoken of as mines, and went to considerable depths, as in Jashpur, they were not in the original matrix rock, but in detrital deposits from the metamorphic rocks. The first samples of dust yielded, on assay by Dodd, gold, 91·667; silver, 3·646; alloy, 4·687=100. Col. Ouseley remarked that this dust had less the appearance of having been worn and flattened than had that usually washed from the sands.

In 1849, Robinson took a lease of the village, with liberty to work the mines, from Government, and left a European agent to conduct operations, who, however, was afterwards compelled to leave in consequence of fever. Indeed, it may be added, the unhealthiness of this region must always prove a drawback to operations under European management. The gold obtained was sold for Rs. $14\frac{5}{8}$ (29*s.* 3*d.*) per *tola* (180 gr.) in the Calcutta bazaar, that being the value put upon it at the Mint.

In 1865, this locality was visited by Col. Dalton, Commissioner of the division, who has written that the production of gold was restricted by the number of washers, there being only six families of them. These people were at work in pits similar to those in Jashpur. The produce of a day's washing for each *duin* or dish was only 3 gr., which led Col. Dalton to suppose some deception had been practised, as the Raja of Sirguja, who contemplated making a monopoly of the industry, was with him. Judging from experience in Singhbhum, however, this amount was probably rather above than below the average earnings.

The other localities in Udepur mentioned by Col. Ouseley as being gold-producing are—

KAMHAR,	on the Korija river,	22° 35′ N.,	83° 18′ 15″ E.
BAIRAGI,	on the Sangul river	22° 42′ 15″ N.,	83° 21′ 30″ E.
SALKA,		22° 43′ 20″ N.,	83° 22′ 30″ E.
KHANDRAJAH,		22° 43′ 43″ N.,	83° 26′ 30″ E.
BAKARUMA,	on the Bharari river,	22° 31′ 45″ N.,	83° 29′ E.
JAMARGI,	on the Maini river,	22° 34′ 30″ N.,	83° 48′ E.

Hyderabad or Nizam's Territory.—The occurrence of gold-dust in the bed of the Godavari has long been known, and mention of it is found in several works published about the beginning of this century.

According to Dr. Walker, there was a gold-mine about the year 1790 near the village of Goodloor [Godalore], near Mungapet, where the Kummamet and Rangheer Circars meet, which had been profitably worked by the Paluncha Raja. At the time of his visit, he could hear nothing locally of this mine, but learnt that washing had been carried on comparatively recently in the streams which feed the Godavari from the south. It was the custom to place bunds across the stream, and, after the rains had ceased, to wash the sand so arrested. The washers belonged to a peripatetic race, who were employed by a rich Bania. Owing to an excessive rent charged by the Raja, operations ceased and had not been resumed.

In the account on p. 323 of the gold-washings of the Upper Godavari district of the Central Provinces, the gold alluded to is really brought into the Godavari by streams in Hyderabad territory, and in fact this Godalore must have been near to and derived its gold from the same sources as Marigudem [Mariguram]. As there are no crystalline rocks in the neighbourhood, it is improbable that there ever was a real mine here. The gold must have been "doubly derivative" from Kamthi rocks. It is perhaps therefore needless to add that gold in quantity is not likely to be found in this locality.

Madras.—The gold-fields of Madras have recently attracted much public interest and a large amount of capital. Very interesting are the speculations which have arisen in connection with the discovery of ancient mines in these regions. That there were formerly large hoards of gold in the possession of the ruling dynasties of Southern India has long been known to be the case. Incredible accounts exist of the vast amounts of bullion which were carried away by the Moslem armies of the 14th century, and they were naturally enough put down as being the product merely of Oriental exaggeration. Pliny, in A.D. 77, referred to the country of the Nareæ as containing numerous mines of gold and silver ;

and that by the Nareæ the Nairs of Malabar were meant is now an established fact. Dr. Burnell has, as the result of his translation of the Tanjore temple inscription, come to the conclusion that in the 11th century gold existed in extraordinary abundance in Southern India. The arguments used by Eastwick (*Gentleman's Magazine*, Jan. 1880) seem conclusive that the Ophir of Solomon was situated on the west coast of India, and that from thence went the ivory, apes, peacocks, and gold, all of which could not have been obtained from any one country to the west of India.

Coupled with the testimony as to the abundance of gold in the country, which is of a most varied kind, there is to be taken into consideration the fact that Brough Smyth and Oliver Pegler, as well as many others, have discovered numerous and extensive ancient mines, which, though they had not escaped the notice of early explorers towards the beginning of the century, have now been brought more prominently forward than they ever were before. Gold is known to exist in the following provinces and districts of Madras: Bellary, Madura, Malabar, Mysore, Salem, Travancore, and Wynaad. Its occurrence in Vizagapatam seems to be as yet unproven.

Bellary district.—Dr. Balfour states that there is a report to the effect that gold was found in streams near Camvehully, and at a hill bearing the name Jageracully, Goodda, &c. The *Bellary Manual*, by J. Kelsall, does not, however, contain any reference to the real or supposed existence of gold among the minerals found in the district.

Madura district.—In the district of Madura, gold is found, according to J. H. Nelson, in two localities, namely, in Palakanuth and in the sands of the Veigei river. Sir W. Ainslie (1813) states that an auriferous zinc-blende was discovered in some part of Madura by Mainwaring.

Gold is washed out of the detritus of the granitic rocks which form the Palani hills near Palakanuth (10° 27′ 30″ N., 77° 50″ E.). Water is scarce, and the work is carried on in a small way, barely affording a subsistence to the washers. D. Muzzy is the original authority for these statements. He suggested deep mining in the soil as being likely to give better results.

Lieut. Nicolson is said to have seen the gold-sands of Polygonuth, 45 miles from Dindigul; whether by this Palakanuth is intended is doubtful, since it is only about 12 miles from Dindigul.

On the Veigei river (10° N., 78° E.) gold-washings take place. The gold is supposed, like that of Palakanuth, to come from the crystalline rocks of the Palani [Palni] hills. The people who search for the gold are called Aruppukarans.

Malabar and the Wynaad.—The Wynaad forms a terrace of mountain-land intermediate in position between the low country of Malabar and the lofty plateau of the Nilgiri mountains. It is separated into three portions, which are locally known as North, South, and South-East Wynaad. Although the south-eastern division of the Wynaad, in which the principal gold-tracts are situated, is now included in the Nilgiri district, it will be more convenient here, with reference to the earliest notices, to treat of it as belonging to the Malabar district, in which it was formerly included.

Probably the first allusion to the existence of gold in this region, since the time of Pliny, is to be found in the report of a joint commission from Bengal and Bombay, which was appointed to report upon the condition of the Malabar province in the years 1792–93. Allusion is made in the report to the fact that the Raja of Nilambar claimed a royalty on all gold found in his territory. In 1793, too, some steps were taken by Duncan, Governor of Bombay, to ascertain the value and extent of the gold-mines of this region. Mention of the fact that gold was worked here is made in Dr. Buchanan's 'Journey.' He alludes to the existence of gold-mines at Malabar in the year 1801, and states that a Nair who had the exclusive right to mine, paid a small annual tribute for the privilege. Owing to the disturbed state of the country, Dr. Buchanan could not visit the locality.

In the year 1802, Sir W. Ainslie recorded several localities in India where gold was then known to occur: among these, Nilambar, the Wynaad, and the sand of the Beypur river at Calicut are included. After the lapse of a quarter of a century, or in 1827, S. Young placed on record that fine specimens of native gold had been found to the west of the Nilgiris in the beds of rivers.

In 1830, F. H. Barber was examined before the Lords Committee on East Indian affairs. He stated that gold was not only obtained in Coimbatore, but throughout the tract of country lying west and south of the Nilgiri and Kunda mountains. He had often witnessed the process of gold-washing, and had bought the gold as it was extracted. He estimated the area over which the soil was impregnated with gold at 2000 square miles. The largest nugget he had seen weighed about half a guinea. The persons employed in washing were the slaves of the proprietors. He attributed the non-improvement in the method of searching to the jealousy of the proprietors. The Government derived a revenue from assessing the *puttis* or trays used to wash the gold, but he did not know its amount. He was sure that the proprietors would be willing to sell their lands at such a rate as would make it worth the while of people of capital to take it; but the Government would not allow Europeans to go into the interior without special permission. There were about 100,000 slaves in Malabar; they were bought and sold like cattle, the value of a man being from Rs. 5 to 20 (10 to 40*s.*).

In some cases, their sole clothing was a plantain-leaf, and their wretched appearance suggested baboons rather than men. They were originally often kidnapped children, stolen at night from their free parents.

In 1831, Sheffield, Collector of Malabar, forwarded a report to Government on the localities where gold was known to occur, and on the methods of mining practised by the natives. He had previously for some time purchased gold from these sources on behalf of the Government. In the same year, Lieut. Nicolson was appointed to prospect for gold-fields, and to purchase on behalf of Government. His reports were on the whole sanguine as to the extent of the mines and the possibility of their being worked profitably by the British, and he suggested that stamping-mills with engine-power should be set up at Coopal. He proposed that a committee should meet there, as a sight of the mines would do more than anything he could write to ensure conviction as to their value. There are frequent references to the jealousy shown by the natives in reference to his researches and inquiries. The Moplahs refused to take service under him at Rs. 5 (10*s.*) a month, as they said they would have to work daily for him, while the gold they could find in one day sometimes enabled them to live in idleness for a week. At Nilambar, the mines were worked by Korumba slaves, who were subjected to horrible cruelties if the gold they found was deficient in quantity.

The report was accompanied by a map showing the positions of the mines, on which it is stated that the largest were at Coopal and Carembat. After receipt of the Report of a Committee in 1833, which condemned working in the low country of Malabar as a European industry, the Governor in Council came to the conclusion that it would be inexpedient to work the mines, and Lieut. Nicolson returned to military duty.

Reports and letters by the Collector of Malabar in 1857 and 1858 directed attention, after another period of a quarter of a century, to these gold-mines, which extended for a distance of 30 or 40 miles along the western faces of the ghâts, and in some places to their summits. The taxes payable by the Rajas for the right to mine had fallen into arrears; apparently many of the older miners and their descendants had migrated to the coffee-plantations of the Western Wynaad.

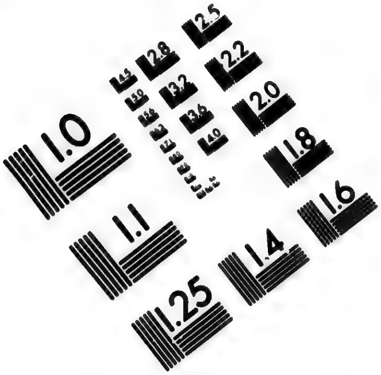
In the year 1865, according to Brough Smyth, among those who were attracted to the Wynaad were H. L. Sterne and G. E. Withers, both of whom had had experience of Australian gold-mining. Soon after, the enterprise of J. W. Minchin led to the erection of machinery to crush the quartz at the Skull reef. Other applicants for the right to mine on their estates then came forward. It would be impossible in this account to give the details of these earliest efforts to put the matter to a practical test, or of those which followed in 1875 and 1876. Their want of success has been fully described by Brough Smyth. Early in 1875, W. King, Deputy Superintendent of the Geological Survey, visited the Wynaad, and soon after his report and map were published.

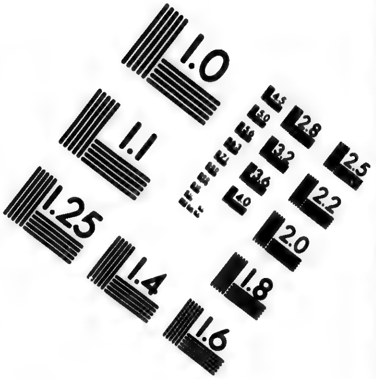
The principal rocks of the area are granites, gneisses, and other forms of metamorphic rocks, which are traversed by numerous quartz reefs. The gold he describes as occurring originally in the reefs or large lodes of quartz, in the leaders or spurs from them, and in the casing rock. In the leaders and casing, the gold is generally visible, either segregated in the interstices of the quartz, or included in the pyrites or the cubes of the same altered into limonite. Invisible gold also occurs with pyrolusite. In the reefs, the gold is generally fine.

The quartz reefs are without exception white at the outcrop, so that it is impossible to say from a surface inspection whether they are auriferous or not. This is the case with the Skull reef of the Alpha Company. The prevailing direction of these reefs is from N.N.W. to S.S.E.; but owing to the irregularity and the occasional flatness of the underlie, it is not always easy to trace them individually, though the Monarch reef appeared to be traceable for 9 miles.

Brough Smyth's report on the Wynaad gold-fields gives an account of his explorations during the years 1879 and 1880. In the tract to which he gave his particular attention, and which covers 500 square miles, 200 outcrops, not necessarily distinct reefs, were counted; they are stated to be more numerous, proportionately richer and wider, than in almost any portion of Australia. As had previously been pointed out by King, there are no deep leads or accumulations of drifts, such as characterize the Australian fields. The ancient mines indicate different degrees of knowledge in the miner's art. They consisted of—(1) quarrying on the outcrops of veins, (2) vertical shafts, (3) adits, (4) vertical shafts with adits, (5) shafts on underlie. Among these, the most remarkable are the vertical shafts; even when in solid quartz, they are sometimes 70 ft. deep, with smooth and quite plumb sides. What the tools were which enabled the miners to produce such work in hard dense quartz no one appears to be able to suggest. The fragments of stone obtained from these various mines were pounded with hand-mullers, the pounding-places being still seen, and the pounded stone was then, it is believed, washed in a wooden dish and treated with mercury.

Brough Smyth compared the present condition of the country to an abandoned Australian washing, it being covered over with tailings, owing to the industry of the Korumbas. Even yet, however, streaks of fine gold may generally be found on washing a few dishes of the surface soil; and "in the vicinity of the reefs, rather heavy gold is got by sluicing, and, if a suitable spot be selected, the native miners will obtain,





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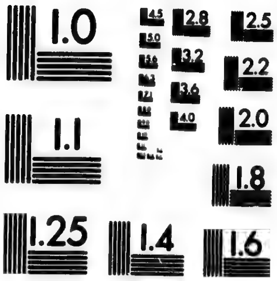

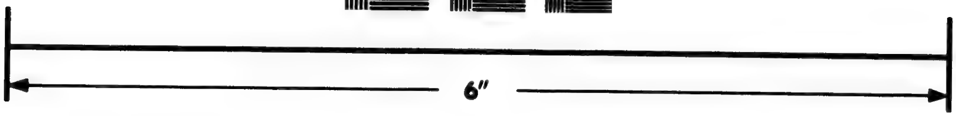

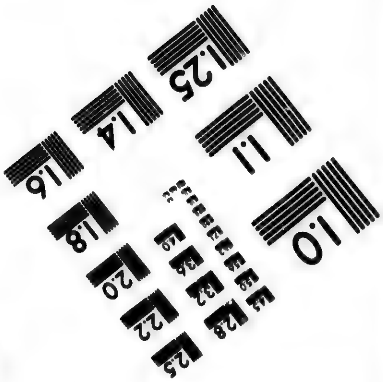

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even by their rude methods, sufficient gold to remunerate them for their labour."

The assays of quartz available at the time, and which had been made by himself, by Tween in the laboratory of the Geological Survey office, and by other analysts, numbered 137, of which the following is an abstract:—

Name of Reef.	No. of Samples assayed by			Average yield of Gold per ton.			Remarks.
	B. Smyth.	Others.	Total.	oz.	dwt.	gr.	
Alpha Company's works	..	6	6	0	9	16	
Skull reef workings ..	7	10	17	3	3	10	1 out of the 17 cases had no gold.
Wright's level	11	7	18	18	9	1	Out of the 18, 2 showed fine specks of gold and 1 assay was lost.
Prince of Wales' reef ..	6	..	6	0	3	12	
Cavern reef	13	1	14	0	18	21	
Korumba reef	1	8	9	1	3	1	Out of the 9, 1 had traces of gold.
Bear ,, ...	4	4	8	0	11	18	Out of the 8, 1 had no gold and 1 had a few minute specks.
Hamslade ,, ...	1	4	5	0	6	13	Out of 5, 1 had minute particles of gold.
Dawson's ,, ...	3	..	3	0	12	9	
Karambaut ,, ...	4	..	4	0	12	15	Out of 4, 1 had specks of gold.
	50	40	90	2	13	2	

If from the above, an exceptional sample from Wright's level, which gave 204½ oz. per ton, be omitted, and also picked specimens from the same workings which gave 25½ oz. per ton, there remain 88 samples yielding an average of 1 oz. 8 dwt. 22 gr. per ton.

As to the quality of the gold, it has been found to be unequal, that from the soils (alluvial) being finest.

Two samples of surface-gold obtained by King were assayed in Calcutta and yielded—

	No. 1.	No. 2.
Gold	93·00	90·90
Silver	7·00	8·67
	100·00	99·57

The average of 6 assays of reef-gold gave—

Gold	86·86
Silver	10·96
Dross	2·18
	100·00

The very important question of mineral rights is now believed to be on a more satisfactory footing, the Government having determined to make the terms of the mining leases as simple and liberal as possible. It is not proposed to levy any royalty or other tax on the industry for the present, because it is deemed most important to attract capital to the gold-fields. The pioneers will have to buy their experience in many directions, and it is undesirable that the first ventures should be unsuccessful.

Brough Smyth, in his special report to Government, discussed the cause of failure of the Alpha Company. The machinery and the management were both unsuited to the requirements of an economical system; yet, in spite of these, the gold obtained was, from 779½ tons, 2 dwt. 9 gr. and, from 32,266 tons, 10 dwt. 12 gr. per ton. In his concluding remarks, he speaks with confidence as to the future of the industry, and says that failure can only result from want of care and forethought, as the resources are large.

The following estimate of the cost of working a company, by Ryan, is stated to be based on actual experience; but no means of confirming its accuracy or otherwise are available, and all the figures relating to cost will necessarily vary in every instance.

It being assumed that a concession of value cannot be now obtained at a less cost than 60,000*l.*, the following is taken to represent the first year's expenditure:—

	£
Price paid for concession	60,000
Cost of machinery, 100 stamp-heads at 200*l.* each	20,000
One year's working expenses	12,000
Contingencies, law charges, &c.	8,000
Total amount of capital	£100,000

Taking the value of gold at 3*l.* 15*s.* an oz., the return from 25,000 tons of ore, containing 3 to 10 dwt. of gold per ton, would be as stated below; the cost of production is assumed at 9*s.* 6*d.* per ton.

	Total.	Value.	Cost of production.	Profit.	Percentage on capital of 100,000*l.*
	oz.	£ s.	£	£ s.	
If yield is 3 dwt. per ton ..	3,750	14,062 10	11,875	2,187 10	2·19
„ 4 „ „ ..	5,000	18,750 0	11,875	6,875 0	6·87
„ 5 „ „ ..	6,250	23,437 0	11,875	11,562 0	11·56
„ 6 „ „ ..	7,500	28,125 0	11,875	16,250 0	16·25
„ 7 „ „ ..	8,750	32,812 10	11,875	20,937 0	20·93
„ 8 „ „ ..	10,000	37,500 0	11,875	25,625 0	25·62
„ 9 „ „ ..	11,250	42,187 0	11,875	30,312 0	30·31
„ 10 „ „ ..	12,500	46,875 0	11,875	35,000 0	35·00

Mysore province.—In the year 1802, Capt. Warren, then engaged in the survey of the eastern frontiers of Mysore, in the Kolar district, hearing of a rumour that gold had been found at the Yerra Baterine Hill, instituted inquiries which led to the discovery that there were gold-washings near the village of Wurigam [Urigam, Ooregaum], and actual mining at Marcurpam, the quartz which was taken out being pounded into dust by women, and then washed.

An Amildar informed him that Tipu had formerly sent a Brahmin to work the mines, but as the cost equalled the outturn, they were given up. But the rayats said that this Brahmin had never personally visited the mines. He mentions that in 1800 he had been told in the village of Cargury, on the Poni-aur, that in prosperous years, when there was an ample harvest, grains of gold were sometimes found in the ears of paddy growing below a tank. This sounds like a metaphor and suggests chaff. Capt. Warren regarded it as a fabrication at first, but subsequently, his attention having been drawn to the existence of gold at the other localities, he proved its presence here by the aid of washers from Wurigam, and thought there might have been something in the story. Paddy, however, has not ears like wheat or barley, and it seems incredible that the rising plant should be able to carry up grains of gold from the soil. It would appear from his descriptions that the laterite is auriferous, a very probable contingency where it is of detrital character. Over an extended area, about the Manigatta, Wullur, and Yeldur Hills, from Budikote to Ramasamudra, Capt. Warren proved the presence of gold in the surface soil and in the beds of rivers. The people who washed were Dherus or Pariahs, and he seems to think that agriculture was for them a more profitable profession.

The description of two mines then follows, one at Kembly, 30 ft. deep and with a gallery of 50 ft.; the other west of Surunpally, which was 45 ft. deep and 56 ft. in extent. It is evident from the sections given that these were not in solid rock; but masses of quartz in an ochreous matrix were taken out to be crushed. Heyne alludes to Warren's researches, but speaks of the gold as being only found in small quantities. Specimens of gold *in situ* from this region appear to have been collected from time to time by Capt. Arthur, Lieut. Puckle, and Dr. Orr. Owing to accidents in these deep alluvial mines, Gen. Sir Mark Cubbin, when Commissioner of Mysore, is said to have prohibited any more being sunk. Recently it has been asserted that Tipu had a mint for gold coin in the neighbourhood of Ooregaum. If he had, it is strange that Capt. Warren did not refer to it.

The recent growth of the gold-industry in this province can only be gathered, in part, from the following statements in successive Administration Reports. In 1868, it was stated that alluvial gold was occasionally found near Betmangla, but in too small quantities to repay labour. In 1870, it is said that washers earn 4 *annas* (6*d.*) a day by washing at the foot of the Hemagiri Hill, in the Huliyurdurga taluk of the Nandidrug division. In 1872–73, 4 lb. of gold was found in the Betmangla taluk. In 1873–74, 6 lb. of gold was obtained in Kolar, and an opinion is expressed that a proper system of working would prove the existence of a considerable quantity of gold in certain districts. In 1874–75, 3 lb. of gold was obtained in Kolar, and 20 rupees' (2*l.*) worth in the Honnali taluk of the Shemoga district. Permission to prospect for gold and other metals was granted to Lavelle for 3 years. Leases for 20 years would be granted to him for blocks not exceeding 2 square miles each in extent, and 10 in number. The report for 1875–76 states that the terms of the leases had been modified, and that prospecting was progressing. In 1876–77, the Urigam [Ooregaum] Company is referred to as not then having commenced operations.

In the reports for 1877–78 and 1878–79, there is no information, and in the table on mines and quarries the statistics of iron, stone, and gold are lumped together. In the last report (1879–80), gold is not alluded to, except in a similar table, though it is stated that iron and potstone are the only minerals worked in the province.

Some information on the gold of Mysore will be found in the Gazetteer of Mysore and Coorg, but most of the facts are derived from the sources of information given above. It is stated, however, that platinum has been found with the gold in the washings, and that the experimental crushing of some quartz was reported to have given a return of 6 oz. of gold to the ton.

It is known that the rocks of Kolar, and probably of the whole of Mysore, belong to the metamorphic or crystalline series ; but there has not yet been any detailed geological survey. It is stated that there are numerous quartz reefs, and that 17 tons of quartz, crushed on the property of one of the companies, yielded 2 oz. 8 dwt. of gold per ton, the silver alloy in the gold being 7½ per cent.

If this rate of production, or perhaps even half of it, should continue, says Ball, it is possible that those among the half-dozen companies which have recently been started in Mysore, whose management is good and whose preliminary expenditure has not been too heavy, have a profitable career before them. The climate, at the average elevation of 3800 ft., is said to be equal to that at Bangalore ; there is a line of railway close by, and labour and water are abundant.

Salem district.—Heyne refers to some gold-mines which were at Suttergul, near Pangumpilly, in the year 1802. He was prevented from visiting them, owing to a rebellion. They appear to have been either on the borders of Mysore, or in the Salem district ; probably the latter, but the names are not on modern maps. They were perhaps not far from Royacottah.

According to Capt. Campbell, gold used to be found at the base of a hill called Kanjah Mallia, on the road from Salem to Sankerrydrug. After the rains, a number of people washed for it in the streams. The earnings of a washer never exceeded 8 *annas* (1*s.*).

Travancore state.—The excitement caused by the recent operations in the Wynaad has led to attention being directed to adjoining areas in Southern India where crystalline rocks occur, and in which it was thought auriferous reefs might possibly be found. Among these areas, the Travancore state has to some extent been prospected, and in Wyld's map of the gold-bearing regions of Southern India, it is represented as an auriferous tract,—upon what authority, says Ball, is not stated, but it may be claimed for this discovery, if true, that it is also new. Travancore does not appear in any of the early accounts as a gold-producing region, and the trade of the gold-washer seems to be there unknown.

W. King has recently (1881) reported on the subject to the Travancore Government. He states that the so-called quartz reefs of Peermerd and the adjoining country are not really reefs, but are the outcrops of beds of quartzite including felspar, which run with the gneiss; only in one case is the outcrop sufficiently large to promise a good tonnage of stone. Although a close assay has detected traces of gold, the amount would not justify the application of the term "auriferous quartz." In the Annamalais, King did not observe any reefs so far as he had examined the area; and throughout the northern parts of Travancore, he saw nothing to justify a hope that regular auriferous rocks would be found.

A sample from one of these outcrops, which was assayed in Madras, was only about 2 lb. in weight, so that the amount of gold per ton (2 dwt. 1 gr.) was calculated from the $\frac{1}{1120}$th. Until a number of assays of large samples have been made, no safe conclusions can be arrived at as to the average amount of gold contained in this quartz rock. King states that an expert was engaged on behalf of one of the Gold Companies in exploring the southern part of the province, and that it was expected that the question would soon be settled for that area.

Nepal, Darjiling, and Sikkim.—Although gold is not known to be washed for in Nepal, Sikkim, or Darjiling, there is reason for believing that it exists in these areas under similar conditions to those prevailing in the N.W. Himálayas.

In an account of the mineral productions of Nepal, by B. Hodgson, gold is not mentioned; and in a description of the process of refining gold in Nepal, Dr. Campbell states that the gold which is subjected to this process is imported from Thibet, to the value of 2 *lakhs* (20,000*l.*) per annum. The fact that there is no published record of the occurrence of gold in Nepal is doubtless due to the notoriously scanty information which we possess regarding the minerals of that country. Mineral productions are precisely what Native Governments are most particular to conceal; but we are not left to hypothesis alone for arriving at the conclusion that gold does exist, since, in one of the British districts at the foot of the hills, it is actually washed for; and though, politically speaking, it may be incorrect, yet, from the geological point of view, it will be most convenient to describe this source of gold here.

A number of rivers and streams which take their rise in the outer ranges of Tertiary (Siwalik) rocks, on the borders of the Champaran district and Nepal, are known to be auriferous, and gold-washing takes place annually, at the commencement and termination of the rains, in the Pachnad, Hurha, Balwi [Dhar], Achni and Kapan rivers.

In the Statistical Account of Bengal, from which this information is derived, the opinion of a Revenue Surveyor is quoted without a suggestion of dissent to the effect that since the streams rise in these outer hills, the drainage of Nepal being cut off by a high range, and since the former have a rugged and precipitous aspect, therefore veins of gold might be found which would amply recoup the Government for any outlay it might incur in working them. That *veins* of gold occur in these rocks is, however, in Ball's opinion, most improbable. The gold included in them is almost certain to be of detrital origin, and, like the materials generally of which the beds are formed, it was brought down from the higher ranges of crystalline rocks inside, which, therefore, contain the veins or other original matrix. The gold-washers of Champaran belong to a race called Tharu, and are, it is said, evidently of Mongolian origin, having similar features to those of the Mechs and Kacharis of Assam and the Bhutan Duars. Their earnings, it is believed, vary from 4 *annas* to a rupee (6*d.* to 2*s.*), which gives a higher average than in almost any other part of India; it is possibly an over-estimate.

On the other hand, the gold must be of very inferior quality, if it be true, as is stated, that it only fetches Rs. 12 (24*s.*), or three-fourths of the ordinary price, per *tola* (180 gr.). Nuggets of gold are said to occur there sometimes in stones which bear the imprint of fossil shells. It is probable that this supposed form of the gold is only iron-pyrites. During the time the revenue survey was in progress, the amount of gold collected was very much less than it had been formerly, when, according to report, the Raja of Ramnagar collected several thousand rupees' worth annually.

In a somewhat speculative paper published in 1848, Dr. Irvine starts the hypothesis from *a priori* considerations, that gold and the ores of other metals probably occur in the rocks forming the hills near or rather above Darjiling; that such is the case, has been proved with reference to the latter, and the discovery of traces of gold-dust in the streams would, says Ball, only be the fulfilment of a most reasonable anticipation.

North-west Provinces.—Gold-bearing sands occur in some of the rivers of Kumaun and Garhwal, and, as in the case of the Punjab, in some of those which take their rise in the outer ranges of hills formed of Tertiary rocks. Several of the rivers in the Moradabad district used formerly to be washed, as described below, if they be not still. The earnings of the washers, as stated to Capt. Herbert, did not exceed 2 *annas* (3*d.*) per man, but he thought this an under-estimate. Other authorities put them at 3 to 4 *annas* (4½ to 6*d.*). The industry was a source of revenue to the Gurkha Government; but when the country became British territory, the smallness of the sum caused it to be remitted by the Commissioner. In the Moradabad district, in 1833, according to Ravenshaw, the gold-washers or Nariyas of Kot Kadir paid Rs. 50 (5*l.*) a month, and those at Barapura Rs. 30 (3*l.*), to the zemindar. On the washers in the Dhela river, a tax of Rs. 2·8 (5*s.*) was levied for each washing-trough (called locally *katouti*), which was paid to the Government. The use of mercury was known to these washers, as it was in the Punjab.

Garhwal.—The Alakananda river and its tributary, the Pindar, contain auriferous sands. Moorcroft describes the process of washing as it was carried on in the year 1819, and Capt. Herbert states that he obtained a speck of gold in granite at Kedernath, near one of the sources of the Alakananda. The whole courses of these two rivers are situated within the limits of the crystalline rocks. The Ganges, where it traverses the outer zone of Tertiary rocks in Chandi taluk, also contains gold, which is possibly locally derived, though some of it may come from the higher ranges, as no doubt all did originally.

Both the Benigunga and Sona have short courses in the outer hills, till they join the Ramgunga in the Patli Dhun: the gold found in them is probably all "doubly derivative."

Gorakhpur.—Small particles of gold are found mixed with the sands of the Great Gandak; and those sands are sometimes washed to find the precious metal. But the particles are far fewer than higher up-stream, in the Nepal Tarái; and Lumsden reckons that to recover Rs. 10 (20*s.*) worth of gold must cost the sand-washers of Sidhua-Jobna almost double that amount in time and labour.

Moradabad district.—In a paper by E. T. Ravenshaw (1833), an account is given of the gold found in the tributaries of the Ramgunga, along the northern frontiers of the Moradabad district. The river in which gold-dust is most abundant is the Koh, which flows a few miles to the east of Naginah, and falls into the Ramgunga, 4 or 5 miles below Sheakdi (? Sheikdih). Four parties of gold-washers, locally called Nariyas, used to carry on their operations at Kot Kadir, 12 miles from Kotdwar, whence the Koh issues from the hills; at Barapura; at Lakher ghât, on the Ramgunga; and at Amangarh, on the Phikanadi, a tributary of the Ramgunga.

In the Dhela, between Sheonathpur and the hills, 10 miles farther east, gold was sought for in the rains by Nariyas, who lived at Kheloroli, 7 miles north of Kasipur. The gold from this river was said to be of better quality than that from any of the others. No gold was known to exist in the rivers farther east in this district, and its presence in the rivers of the Bareilly district had not been ascertained.

Orissa.—Within the limits of the province of Orissa, gold-washing is or has been carried on in the Native states of Dhenkanal, Keonjhar, Pal Lahara, and Talchir. It is a poor pursuit, as in so many other parts of the country, but the fact is interesting as affording evidence of the existence of gold.

Stirling alludes to a report that gold is found in some of the streams of Dhenkanal; and in the Statistical Account of Bengal, washing for it is said to take place in them to a small extent. There was no washing going on there in the early part of the cold season of 1875–76, when Ball passed through the state. The rocks chiefly belong to the older metamorphic series, but there are also some Gondwanas.

The evidence of gold-washing being practised in Keonjhar (21° 37′ 30″ N., 85° 34′ 15″ E.) is identical with that given for Dhenkanal. There is reason for believing that in Keonjhar both metamorphic and sub-metamorphic rocks occur.

In the Brahmini river, where it traverses Pal Lahara (21° 22′ N., 85° 11′ E.), gold-washing is carried on somewhat more actively than in the before-named states. Farther north, in the bed of the Brahmini, in the Bonai state of Chutia Nagpur, there are also gold-washings, as noted on p. 324.

Within the limits of the Talchir state (20° 57′ N., 85° 13′ 30″ E.), gold has been washed for to a small extent in the Brahmini and its tributaries, especially in the Tikaria and the Ouli. In the former case, it is probably directly derived from metamorphic rocks; but in the latter, it must have a "doubly derivative" origin, since the Ouli flows through coal-measure Gondwana rocks, namely, Kamthis and Barakars.

Punjab.—It has been not unfrequently stated that all the rivers of the Punjab, the Ravi alone excepted, contain auriferous sands. Probably there are some others which might be excluded from so general a statement; but the fact remains that the rivers and streams of the province, whether rising in the distant ranges of crystalline rocks forming the axis of the Himálayas, or merely having their sources in the outer and lower ranges of hills formed of detrital Tertiary formations, do as a general rule contain gold. In the latter cases, the gold must have a "doubly derivative" origin, and no veins, or other original deposits of it, can be expected to occur.

The practice of gold-washing in the Punjab is probably of considerable antiquity; formerly it afforded a source of revenue, and, under the Sikh Government, the tax amounted to one-fourth of the gross produce. As in most other parts of India, the possible revenue from this source has dwindled down to very small proportions, or has become wholly extinct; in the year 1860–61, it was Rs. 444 (44*l.*) and in 1861–62 it was Rs. 530 (53*l.*). The fact of gold being obtained by washing in the rivers of Subah Lahore is mentioned in the "Ain-i-Akbari." The chronicler, or rather his translator, as Ball observes, includes brass in the list of metals which were thus obtained!

The following account contains the most important authentic information on the subject of Punjab gold, the districts in which it is found being Bannu, Peshawur, Hazara, Rawalpindi, Jhilam, Amballa, and certain Native States.

Amballa district.—Specimens of gold from the Markunda river, near Karrar, were exhibited at the Lahore exhibition. In Balfour's Cyclopædia, it is stated that gold has been found in large quantities between Amballa and Kalka, but the original authority for the statement is not mentioned.

Gold-washing, as carried on in the year 1835 in the river Gumti (30° 34′ 30″ N., 77° 13′ 75″ E.), which was so called after two villages bearing that name, and situated on its banks, was described by Lieut. Cautley. From the description given, though it does not exactly coincide with the relative positions of the places mentioned, it would seem that Gumta of the modern maps, which is to the west of Nahan, was the locality referred to. The Gumta [Gumti] stream is parallel to the Markunda. The washers, of whom there were only a few, carried on their operations with a large trough and sieve, as elsewhere, and employed mercury for the final process. The gold was said to be very fine.

A royalty of 1 *masha* (Rs. 192 = 19*l.* 4*s.*) was levied by the Raja of Nahan. The daily earnings from one trough worked by two men varied from 2 *annas* to Rs. 2 (3*d.* to 4*s.*). A hope was expressed that the gold would prove as abundant as the Siwalik fossils, which about that time were first discovered.

Bannu [Bunnoo] district.—At Kalabagh and other points on the Indus below it, gold-dust is washed for, the annual value of the produce being estimated at Rs. 200 (20*l.*). Whether this gold is derived from the Tertiary rocks, as is that which is obtained in the streams and rivers from the Salt-range in the Jhilam district, or has come from the older rocks higher up the valley, may be an open question.

Hazara district.—The bed of the Indus in this district also yields gold-dust, the quality, and therefore the value, of which is the same as of that obtained within the limits of the Peshawur district. The most prolific portion of the Indus is said to be that which traverses Dardistan.

Gurgaon district.—But one locality, Sona [Sohna] (28° 14′ N., 77° 7′ E.), is known in this district where gold has been found. It is possible that this place may owe its name to the fact. When examining the schists of the Arvali series, Hacket was informed that small quantities of gold are found, after the rains, in the streams which take their rise in the hills close by.

Jhilam district.—The gold-washings of the Salt-range are nearly all included in the Jhilam district. They are situated in the beds of streams and rivers which take their rise in the sandstones of Tertiary age, the gold apparently coming from beds of the lower Siwalik group. It has thus a "doubly derivative" origin, as in these beds it is, like the rest of the materials of which they are formed, merely detrital matter from the old crystalline rocks of the Himálayas. Much of the gold is invisible or nearly so, and would be lost but for the employment of mercury. In the year 1850, 158 cradles were worked, and the tax upon these amounted to Rs. 525 (52*l.* 10*s.*).

In 1848, Dr. Fleming was informed, according to Baden-Powell, that the production of gold was as follows:—

1844	409 *tolas.*
1845	272 „
1846	332 „
	1013 *tolas* × 16 = say 1620*l.* 16*s.*

The Bunjar river, near the eastern end of the hills, is specially mentioned by Wynne as producing gold, and from it, westwards up to the Indus, many of the streams which rise on the northern flanks of the range contain gold.

Kangra district.—In this district, gold is found in the Bias river, near Haripur, and also in Spiti, Kulu, and Lahul.

In a paper by Capt. Abbott, the process of gold-washing in the Bias river is described and illustrated. The gold occurs apparently in still finer particles than elsewhere, being literally dust. It is impossible to say what may be the proximate derivation of this gold, as the river traverses both Tertiary and old crystalline rocks. Since gold occurs at Shamsi, higher up the valley in Kulu, it originally probably all came from that neighbourhood. Traces of gold occur in the argentiferous galenas of Kulu, and the sands of several streams in the same district are believed to be auriferous. Gold is obtained in the larger rivers of Lahul and Zangskar, but the outturn is small; it is mostly taken to Hindustan. In Kunawar, according to Gerrard, small quantities of gold are found in the streams. The position of Kunawar is in the valley of the Sutlej, to the north of Bisahir [Bashahr], on the frontiers of Chinese Tartary. Granite and other crystalline rocks are found there, and from these, or rather from the quartz veins which traverse them, the gold has probably been derived.

Peshawur district.—In the Indus above Attock, and in the Kabul river, gold-dust occurs, though not in great abundance. There are about 150 men who wash during the cold and hot seasons; for the rest of the year, they follow their regular avocation as boatmen. They often receive advances from those who purchase the gold, which is valued at Rs. 15 (30*s.*) a *tola* (180 gr.). Each man obtains on an average 2 to 2½ *tolas* (360 to 450 gr.) of gold, which, from the time spent in its collection, would yield a daily wage of about 2 *annas* (3*d.*).

Rawalpindi district.—The sands of the Indus at Attock (33° 52′ 30″ N., 72° 15′ 30″ E.) are also washed for gold. Dr. Jameson (1843) stated that about 300 individuals used then to engage annually in the search for gold between Attock and Kalabagh. The washing was effected with the aid of a large wooden trough. Mercury was used, and the gold obtained was sold for Rs. 16 (32*s.*) per *tola* (180 gr.), one-fourth of which was claimed by the Sikh Government. The actual earnings of the men were estimated to be 3 to 4 *annas* (4½ to 6*d.*) a day.

Patiala state.—In the Native state of Patiala, gold is washed for by the Sonjbirs in the bed of a small mountain stream, according to Dr. Balfour.

Rajputana.—According to Dr. Irvine, gold-dust used to be found in the sands of the Luni and Khari rivers. The search, however, does not appear to be carried on at present. These rivers traverse rocks of the Arvali series and gneiss. The actual source of the gold is unknown. As rough indexes of position, Raipur on the Luni (26° 3″ N., 74° 5′ E.) and Sagramgarh on the Khari (25° 52′ N., 74° 29′ 30″ E.) may be mentioned.

JAPAN.—The most extensive account of gold in Japan is given by Henry S. Munro, from whom the following extracts are taken.

According to Japanese historians, gold was first found in Japan in the year 749 A.D., about 80 years after the discovery of silver, which statement Munro considers open to great doubt, as gold is often brought to view in grains or nuggets by the natural action of running streams, and easily obtained by gravel washing, while silver rarely occurs native, and requires a metallurgical process for its separation.

During the 90 years in which the Portuguese exported gold from Japan in such large quantities, the gold-mines must have been taxed to their utmost to keep up the supply. This export averaged 3½ million dollars (666,666*l.*) a year; and with the most ample allowance for the supply derived from the hoarded gold of centuries of non-intercourse, the annual yield of the mines must certainly have been more than $2,000,000 (400,000*l.*). It is also probable that the mines reached their maximum production during this time; for so great a demand must of necessity have stimulated the supply. Indeed, partial confirmation of this supposition is found in the steady increase for a long period of the amount exported, which at one time reached the sum of $12,000,000 (2,400,000*l.*) for a single year.

From present knowledge of the character of Japanese gold-deposits, it is evident that this great yield was obtained from placer-workings. These, being shallow and of small extent, were quickly exhausted; and the attention of the miners was then turned to the quartz veins, which thereafter yielded small but more constant returns. When, however, the imperial edict of 1671 put a stop to the exportation of bullion, this exhaustion of the placers had hardly begun to show itself; for the annual exportation of the Dutch between 1649 and 1671 averaged nearly $3,000,000 (600,000*l.*),—but little less than that of the Portuguese in the previous century.

The yield of gold in 1874 is estimated by J. G. H. Godfrey at 100 *kan* (about 12,150 oz. troy). This shows that there has been a great falling off in the production; 12,000 oz. are worth but about $250,000 (50,000*l.*)—a very small proportion to the annual export of former times.

Gold occurs in about one-half of the *ken* and *fu* of Japan; but in most cases the deposits are not now worked. The records of the Mining Office show that permits were granted in 1874 for the working of 58 gold-mines. Of these, Munro could learn of but 6, worked solely for gold, which produced notable amounts of bullion; and of the 6, 3 together produced, in that year, but 50 oz. Most of the gold now comes from mines worked for silver. Mines producing gold alone are, as a rule, not worth working.

Gold occurs in Japan in quartz veins and placer deposits, as well as in association with silver and other ores. The placer deposits are generally of fluviatile origin, and the gravel beds are thin and of limited extent. They are often found covering the terraces of the river valleys. These placer-deposits are uniformly poor. The richest gravel found in Yesso yielded less than 7c. (3½*d.*) to the cub. yd., while the average of even the best field was only 5½c. (2¾*d.*). From information gathered from various sources, he infers that this is about the usual richness of similar deposits—even the most celebrated—in other parts of the country.

The quartz veins, as a rule, are also very poor. Rich quartz is found only in small and thin deposits. The usual yield is about ⅓ to ½ oz. to the ton. In exceptional cases, the yield may be as much as $90 to 100 (18 to 20*l.*); but the veins are then so thin that the extraction of the ore becomes very expensive.

The methods employed in the separation of gold from the quartz of the veins and from the gravel of the placer deposits are exceedingly interesting. The method of extraction is, in either case, purely mechanical. The gold-bearing quartz is first crushed, and then ground with water, repeatedly and in small quantities, between heavy millstones moved by hand, until reduced to an impalpable slime. This, as it issues from the mill, is largely diluted with water, and conducted over a series of short and narrow boards covered with numerous diagonal saw-cuts. These boards, which collect the gold and other heavy metals very perfectly, are frequently cleaned in a tank; and the concentrated material so collected is washed with great care and skill on the board or *batea* of the gold-washers.

According to careful experiments made by Carlyle while in charge of one of the Government gold-mines, this process extracts, at the first working of the ore, 65 per cent. of the assay value, and the re-working of the slimes yields an additional 15 to 20 per cent. Before the material is considered by the Japanese to be exhausted, it is treated a third time by the same process, bringing the proportion of gold saved to fully 90 per cent. of the assay value.

The method of washing employed in the working of the gravel deposits is briefly as follows. Ditches are cut from convenient streams in such a way that the water flows over the bed-rock through the gravel deposit. A certain quantity of gravel is brought into the ditch by undermining the bank. The larger stones are carefully washed by hand and thrown out of the ditch, and the smaller ones are separated with the aid of proper tools. The rapid current at the same time washes out the clay and fine sand, leaving a bed of fine gravel only in the ditch. When this has reached a thickness of about 1 ft., 2 or 3 small straw mats are placed side by side in the bottom of the ditch near the head of the working; and the gravel, a little at a time, is hoed carefully over them. As the gravel is swept over the surface of the mats by the force of the current, the heavy gold and the iron-sand sink between the thick twisted strands of straw, and so are retained. From time to time, the mats are moved a few ft. down stream, and the new material exposed by their removal is hoed over their surface in the same manner until finally all the gravel has thus been several times subjected to treatment.

During the operation, the mats, as they become charged with gold, are taken from the stream and others are substituted. The concentrated material collected by the mats is finally washed with great care on the *ita* [washing-board], for the separation of the gold.

Gold-fields of Yesso.—A description of some of the Yesso gold-fields, condensed from Munro's report to the Government, will serve to illustrate the general character of the placer deposits of Japan. Gold-bearing gravel is found on the island in many of the river-valleys, apparently divided in every case from the metamorphic strata of the immediate vicinity. These deposits in each of the more important fields are found in the wider portion of the valley, where the river passes through some soft and easily eroded formation, and where a large reservoir has thus been formed to receive the gravel. Where the valley is wholly in metamorphic strata, it is, as a rule, quite narrow, and the deposits of gravel, though perhaps not poor, are of little value, because of limited extent. Again, where in the gold-regions the valley is entirely within the limit of the soft strata, the gravel will be composed chiefly of fragments of sandstone and shale, and will contain little or no gold.

These auriferous gravels everywhere afford unmistakable evidence of having been deposited in running water; and the direction of the old current, which can usually be determined by the position of flat stones in the beds, coincides, as a rule, with the general course of the present river-valleys.

The most important gold-field of Yesso is in the upper valley of the Toshibets river, in the province of Iburi. The river here passes through the Toshibets series of clay rocks and tufas, and the valley is wide and deep. The gold occurs in the river gravel, and the deposits extend for a distance of 5 or 6 miles along the valley. The hills on either side are 800 to 900 ft. high, and 1000 to 1200 ft. above the sea.

The bottom of the valley lies in 3 or sometimes 4 terraces, which are about 12, 40, 85, and 260 ft. respectively above the level of the stream. Each of these terraces is underlaid by clay rock, and represents a former bottom of the valley. They are covered by beds of gold-bearing river gravel, which are usually 9 to 12, but sometimes as much as 30 or 40 ft. in thickness. The gravel in turn is covered by yellow sand and loamy silt, usually only a few ft. in thickness, but in the case of the highest terrace fully 50 ft.

The gold is found to be concentrated in the lower layers of the gravel beds and next the bed-rock. This concentration is probably due to the repeated stirring and rewashing of the gravel as the old river shifted its bed from one side of the valley to the other. The richness of the gravel also increases very perceptibly on ascending the stream, indicating the probable source of the gold. Numerous tests were made in different parts of the field by a modification of the Japanese method of gold-washing. In each case, several cub. yd. of gravel were treated. These tests yielded 1 to 2 gr. of gold per cub. yd. of gravel washed. The average value of the gravel for the whole field would seem to be about

3¾c. (1⅞*d.*) per cub. yd., and for the upper and more productive part of the valley, perhaps 5⅓c. (2⅝*d.*).

On the Musa river, in Oshima province, is another large gold-field, similar to that of the Toshibets, but much poorer. The upper valley of the river is in metamorphic strata, and is quite narrow and deep, the hills on either side being several thousand ft. high. The lower valley is in the soft strata of the Toshibets and Chingkombe groups—clay rocks and shales—and is quite wide, and surrounded by low hills. The transition from the narrow ravine to the broad valley is very abrupt, and marks sharply the line of junction between the hard and soft strata.

The gold-field comprises the upper 5 or 6 miles of the broader portion of the valley. The gravel covers the terraces and the bottom of the valley in regular beds averaging 8 ft. in thickness, varying between 5 and 13 ft. in different localities. As on the Toshibets, the gravel beds are everywhere covered with sand and silt, 3 to 10 ft. thick. The gravel is composed of pebbles of metamorphic rock; and from its composition, seems to have been derived from the similar metamorphic rocks of the upper valley.

The results obtained from the washing of over 100 tons of gravel, from many different localities, show the field to be very poor. The richness of the gravel varies between 0·13 and 0·5 gr. to the cub. yd.; though in one case it reached 2½ gr. Omitting this exceptional result, the gravel steadily decreases in value from the upper end of the valley to the lower. The average richness is about ¼ gr. per cub. yd.

Near Esashi and Matsumai, in Oshima province, and near Kudo, in Shiribeshi province, are small gold-fields, but these are even poorer than the Musa field. Near Uragawa, in Hitaka province, and extending thence to the Tokachi river, in Tokachi province, is a large gravel formation, probably covering an area of over 100 square miles, which in some places contains gold, but in infinitesimal quantity.

The remains of old workings are to be seen in all these localities, and it would seem that in former times the Musa and the Toshibets fields must have been extensively worked. Indeed, there is a tradition that about the year 1205, a party of several hundred miners from Chikuzen, a province of Kiushiu, came to Yesso, while the island was still in the hands of the barbarous and warlike Ainos, and worked the gold-deposits of the Musa valley and other places in the vicinity. From data obtained in surveying the Musa field, it appears that these old gold-washers must have obtained about $21,000 (4200*l.*) worth of gold from that locality alone, and, as they remained on the island 13 years before they were massacred by the Ainos, they must have secured quite large amounts of the precious metal.

From the extent of the old workings on the Toshibets, this field also must, in former times, have yielded much gold ; but there is, in this case, neither record nor tradition of the old workers. The Toshibets field was, however, worked in a small way about 12 years ago by the government of the Shôgun. A few men only were employed, and the total yield was quite insignificant and hardly paid the expense of working.

Kanaba Gold-mines (Okuzo, Akita kôri, Akita ken).—At the time of Munro's visit, these mines were under the direction of Robert G. Carlyle, an engineer of the Mining Office. Since the death of Carlyle, they have been under the superintendence of R. J. Frecheville, of the same office.

These gold-mines have been worked for many centuries, and hundreds of tunnels and adits penetrate the hills in every direction. A number of these old workings have been re-opened and surveyed. Tunnels over 2 miles in length have been found, and drifts and stopes innumerable,—all driven with imperfect tools, before the time of gunpowder ; and affording, especially in the carefully dressed walls and squared corners of some of the larger tunnels, evidence of slow and patient labour. One of these tunnels is said to have been the scene of a desperate fight between the rival miners of 2 provinces, whose workings, driven from opposite sides of the mountain, met in this place. The connecting winze was afterwards blocked up, and has been only recently re-opened, for ventilation.

The gold occurs in small veins, traversing a porphyritic rock. The veins vary in thickness from 3 ft. to a mere sheet. The gold is associated with copper- and iron-pyrites, blende and galena. The thin veins contain the richest ore, while the larger veins are usually too poor to be worked. The large veins hold copper and lead ; but neither are they rich enough in these metals to be worked. These large fissures are quite regular: run N. and S., and dip 45° to 70° W. They are usually filled with decomposed porphyry, often in the form of a plastic clay. The copper-ore occurs in local deposits of limited extent, near the foot-wall.

The large veins intersect and cut off the smaller gold-bearing veins, these latter being either branches of the main fissures, or faulted to a considerable extent by them. Carlyle was inclined to adopt the former view. There seems to be little parallelism between these gold-veins, though the general direction is about E. and W.

The average richness of the ore, as hand-picked and prepared for treatment by the Japanese process, is about $90 (18*l.*) per ton (containing 4·4 oz. of gold) ; 40 miners produce of such ore only about ⅓ ton a day. Including all expenses, the cost of mining reaches nearly $38 (7*l.* 18*s.* 4*d.*) per ton of 2000 lb.

A 10-stamp mill, of the California pattern, with a capacity of 15 tons of ore per day, has been erected by the Mining Office. In working the mine on the scale necessary to supply this mill, the cost of getting out the ore will be greatly reduced; but, at the same time, it will be impossible for the miners to select, as heretofore, the best places, and the richest mineral. The average richness of the ore mined will not probably be more than $20 (4*l.*) per ton, if indeed it reaches that figure. The cost of treatment by the Japanese process is but $8 65 c. (36*s.*) per ton of 2000 lb., and by the stamp mill will probably be much less, so that the question is whether the cost of mining, now so large, can be reduced to a figure that will permit a profit. The solution of this problem will perhaps determine whether any of the gold-deposits of the country can be worked with profit; for this Okuzo mine, though perhaps not the richest, is better than the average of Japanese gold-mines.

Yamagano Gold-mines (Kuwabara kôri, Kagashima ken).—These mines are owned and worked by a private corporation, the Satsuma Mining Company. A 15-stamp mill, built in France, is being erected here under the superintendence of a Japanese machinist from the Ikuno mines. The mill will be run by a large turbine, and will treat 24 tons of ore per diem.

There are several mining districts in this vicinity. The mines of Nagano, in the neighbourhood of the mill, are at present flooded, and work has been suspended, during the completion of a new drainage tunnel. This, with its branches, it is said will be about 2½ miles in length, and will require 30 years for its construction. The mines which will be drained by this tunnel are reported to be very rich.

In the meantime, the supply of ore is drawn from the mines of Yamagano and Musoyama. The gold occurs in quartz veins traversing a stratified tufa rock. This tufa, which is quite soft, alternates with a hard, dark-blue crystalline quartzite, and in the vicinity are beds of sandstone and shale. Both the quartzite and the shales contain in places prints of maples and other deciduous trees. The strike and dip of the gold-bearing veins correspond usually with the strike and dip of the stratified rocks, and they are apparently bedded veins, though without doubt true fissures. The general direction is E. and W., the dip S.

At Yamagano, the veins are rarely more than $\frac{1}{10}$ ft. in thickness, and when thicker, are too poor to work. The average yield of the ore is about $\frac{3}{10}$ oz. or $6 (26*s.*) to the ton of 2000 lb., which, it is said, does not pay expenses.

At Musoyama, is a vein 5 to 6 ft. thick, filled for the most part with fragments of wall-rock, cemented by thin seams of gold-bearing quartz. The yield of this ore is nearly ½ oz. gold, or $9 70 c.(40*s.* 5*d.*) to the ton. As the vein is so exposed that it can be quarried in the open air, 25 workmen, mostly boys, produce 6 tons of ore per diem. At another mine, Yamanokamiyama, small quantities of ore are obtained, which is said to yield 1·58 oz., or $28 80c. (6*l.*) to the ton.

At both Yamagano and Musoyama, are large deposits of gravel containing gold-quartz. These deposits are washed for gold, and the quartz is picked out by hand; 1 cub. yd. yields about 11 c. (5½*d.*) worth of gold by washing; and the quartz picked out, when crushed and treated by the Japanese process, yields about as much more.

Sado Gold and Silver mines.—The mines of the island of Sado are said to be the richest and most valuable in Japan. They have been worked for more than 1000 years, and formerly yielded much gold. The bullion produced at present is mostly silver, gold occurring in small proportions only.

From a short account of the principal mines given by Gubbins, of the British Legation, in a paper read before the Asiatic Society, in April, 1875, the following details are extracted.

The mines are situated near Aikawa, towards the southern extremity of the island. The old workings, which are very extensive, are of the most primitive kind, and the mines have for the most part been abandoned for want of means to control the water. About 60 years ago, 300 miners are said to have lost their lives by a sudden flooding of one of the principal mines, perhaps caused by the accidental tapping of a large body of water collected in some older working.

Of the character of the deposits, the richness of the ores, and the nature of the work now going on, Gubbins gives no information. He mentions a little episode, however, which illustrates the difficulty sometimes attending the introduction of labour-saving machinery and new methods of working. It seems that a few years ago a tramway was constructed to bring the ore from the mines to the works. Its use, however, has recently been discontinued, because of difficulties of working, frequent accidents, &c.; and it proves better policy and quite as economical to employ women at 4c. (2*d.*) a day to carry the ore on their backs.

The principal problem at present is to drain the mines, and put them in proper working order. It is estimated that it will take 5 years and a considerable outlay of capital to accomplish this. There is, however, ore enough on hand to keep the new smelting works running for 2 years. In the meantime, for various reasons, the mines are being worked at a loss. This is in part due to the unproductive work now carried on, and in part to the Japanese system of administration. In 1 year, bullion to the amount of $60,000 (12,000*l.*) was sent to Tokio from the mines; but the expenses (in part capital invested?) for the same period were $75,000 (15,000*l.*).

The ore occurs in 2 large veins running N. and S. These veins divide into a number of smaller branches, which alone were worked in former times. Of the many old adits, but 6 are in working order: these follow veins 3 to 20 ft. thick. The ore contains gold, silver, copper, lead, and in some places antimony.

It is proposed to sink 3 shafts, 2 for hoisting the ore and one for pumping and hoisting combined. One shaft is to have a depth of 668 ft., with 4 horizontal galleries 2000 ft. long, at intervals of 100 ft. Another shaft will be 902 ft. deep, with 3 galleries 2500 ft. long. The whole work will be completed within 12 years. It has been estimated that 300,000 tons of ore will be obtained in this time, and in the 3 years following an average of 60,000 tons a year.

At present the whole of the ore mined cannot be treated, as the smelting-works are incomplete. In 1873, fully 60,000 tons remained from the working of former years, and during the same year an additional amount of 1867 tons was produced. Of this, but 1217 tons were treated, producing 24,549 oz. of silver and 592·27 oz. of gold, which would be worth about $40,000 (8000*l.*). The ore would thus seem to average nearly $33 (6*l.* 17*s.* 6*d.*) per ton, and to be rather argentiferous than auriferous.

Consul Ensden, reporting from Hakodadi in 1874, says it has always been surmised there was gold in this island, but the spot was unknown, and it was strenuously denied by the officials. A visitor to Hakodadi, on his way to Tagholin viâ this island, told the consul that he came across a party, consisting of 4 Japanese and 5 Ainos, busy washing gold on Government account. This was at Tofui, in the Tokeby [Birs] district, about 160 *ri* from here, on the eastern coast. The gold is found for miles along the beach, which is covered with thick layers of black auriferous sand. The simple process consists in taking up a small basket of sand, washing its contents by the seaside, and collecting the gold, which is prevented from running off by a small sieve at the bottom of each basket. Specimens of gold taken at different places were all equally fine and rich.

J. G. H. Godfrey (1878) states that most of the river-sands, and chiefly those of the northern part of Nippon, contain grains of metallic gold; but it was only in former times, when wages were considerably lower than at present, that these sands paid for washing. River-sands of a better quality are occasionally worked by farmers in the province of Koshiu during the quiet season.

Numerous lodes and deposits containing gold are found in the rhyolitic formation, and in several instances they are cut off by dykes of basalt or dolerite. As a general rule, these lodes or deposits are of rather limited extent; but some of them, as the quartz veins of Sado (prov. Sado), Ikuno (prov. Tajima), and Innai (prov. Uzen), are of considerable size, continue to great depths, and have proved productive for a number of years.

Most of the gold produced in Japan is derived from auriferous silver-ores; it occurs by itself in the metallic state, and in sufficient quantity to be collected by a washing process only in a few localities. The most important auriferous quartz veins occur in the provinces of Koshiu, Ugo, and Satsuma.

At Homura (prov. Koshiu) numerous thin quartz veins of very limited extent are found interbedded in a hard clay-slate. The metallic gold is here associated with small quantities of arsenical and iron-pyrites, blende, and galena. Owing to the hardness of the containing-rock, underground mining has been prosecuted only on a very small scale, and the work has been confined chiefly to the washing of the alluvial deposits in the proximity of the mines. The ground in the neighbourhood of the quartz veins is much broken up, and consequently rapidly disintegrated by atmospheric influences.

At Ooguzu (prov. Ugo) a quartz vein about 2 ft. wide, running nearly N. to S. and dipping 60° W., and numerous cross-veins of smaller size, bearing N.E. to S.W., occur in a greenish soft clay-stone porphyry (probably decomposed rhyolite).

The metallic gold is here associated with copper- and iron-pyrites. A dark-greyish mineral, probably sylvanite, often accompanies the metallic gold. These veins have been mined for many years past, and the gold is collected by stamping the ore and subsequent washing and amalgamation.

At Serigano and Yamagano (prov. Satsuma) numerous quartz veins of greatly varying thickness, running E. to W. and dipping slightly N., are found in a rock resembling decomposed propylite. Usually the gold occurs therein alloyed with silver; and this alloy sometimes partially fills out cavities in the vein-stuff with thin foils studded over with small cubical crystals of the same alloy.

Most of the auriferous quartz-veins in Japan are very irregular in their character and very changeable as regards their yield.

A volume published by the Kaitakushi, Japan, gives the following very interesting and full details of the mode of gold-washing, previously (p. 350), mentioned in general terms. A prospector wished to test some auriferous gravel. The common pan was tried, but the gravel, though washed in small quantities at a time, yielded on some occasions little or no gold, on others it gave very promising results from poorer looking samples. The cradle was tried, but did not recover nearly so much gold as the Japanese method. A sluice could not be used, as it would take too long to construct, and would be too cumbersome to move to different parts of the field in order to test it. The long-tom, though inferior to a sluice, as its shortness causes much waste of fine gold, is nevertheless better than the cradle, and was therefore selected for a trial against the Japanese method. The experiments were made under conditions the least favourable to the tom, the gravel being poor and the gold fine. The results were surprisingly discreditable to the tom. In one case, washing with a limited supply of water, one cubic metre of gravel yielded 30·8 *milligrammes* of gold by the native process, and only 2·6 *milligrammes* or about $\frac{1}{12}$ part by the tom. In a more favourable locality, treating 3 cubic metres of gravel in each case, the former gave at the rate of 68 *milligrammes* per c.m., the latter but 18, or $\frac{1}{4}$. In suitable spots and with more practised workmen, undoubtedly much better results might be obtained, but the experiments sufficed to show that for prospecting in poor gravels the Japanese method was certainly the better as well as the more convenient. It requires but few tools, viz.:—a *tsuru* or pick for occasional use in loosening the gravel; two or three specially shaped *kua* or hoes, for working the gravel in the stream or washing-ditch; a *joren*, or scoop-shaped bamboo basket for removing the coarse gravel; two or three *nekoza*, or straw mats, specially made for collecting the gold; and an *ita* or board, slightly warped and dish-shaped, used as a pan, for separating the gold from the concentrated sand. To these were added a *masu*, or measuring-box made to hold exactly $\frac{1}{2}$ c.m., and provided with a board floor to ensure accuracy; also a couple of shovels were used for filling and emptying this box.

To test the gravel of any desired locality, a place was selected on a small stream, combining if possible, the following conditions:—

1st.—An exposure of the bed-rock below the gravel at least 6 in. or 1 ft. higher than the level of the stream.

2nd.—The whole thickness of the gravel-bed accessible.

3rd.—A velocity of at least 1½ to 2 ft. per second, either in the stream itself, or produced in a washing-ditch 15 to 20 ft. long by a dam or other expedient.

4th.—Sufficient water for washing: 60 to 80 cub. ft. per minute is the most convenient quantity, but much less may be made to do.

A suitable place having been found, the bank is cleared of grass, roots, and soil for a width of about 3 ft. and from the bed-rock to the top of the bank, exposing the whole thickness of the gravel bed. The measuring-box is then placed in position on the bank of the stream and filled with gravel, only boulders of exceptional size being omitted. In the meantime the gold-washers form a washing-ditch by cleaning the bed of the stream for a width of 2 to 3 ft. and a length of 15 to 20 ft. When the stream is large, it is divided, only the volume of water requisite for washing being admitted to the ditch. In thus dividing a stream, care must be taken that the stones of the partition-wall are so placed that all leakage of water shall be *from* the main stream into the ditch, and that there may be no flow in the opposite direction, otherwise much of the measured gravel with its gold will be lost. These preparations completed, the gravel is shovelled from the measuring-box into the head of the washing-ditch, and the box is refilled with gravel. At the same time the men wash and throw out the large stones by hand, and separate the smaller stones from the gravel with the *joren* and *kua*. The rapid current washes out all the clay and fine sand, leaving only the fine gravel in the stream. Riffles are built of flat stones across the lower end of the ditch, to arrest the gravel and to prevent any gold being carried down-stream. When 4 to 6 boxes of gravel have been shovelled into the water, forming a bed of fine gravel about 1 ft. thick, the washing on mats begins. Two or three mats, each 1 ft. wide by 2 ft. long, slightly narrower at the lower ends, are placed side by side across the stream about 2 ft. below the upper end of the gravel. The upper edges of these mats are buried a little in the gravel and held in position by the foot of the gold-washer, usually one man to each mat, the number of men being regulated by the width of the stream. These men now carefully hoe the gravel to the head of the mats, so that it shall be carried over their surface by the force of the current. The heavy gold and iron-sand sink between the thick twisted strands of straw forming the mat, while the lighter gravel passes down-stream. The lower ends of the mats are lifted from time to time and folded over the upper portion, to transfer the gold to the head of the mat and to keep the lower part clean. When all the gravel in front of the mats has been hoed over their surface, the men move them about 2 ft. down stream, and begin to work in a similar manner on the new portion of gravel thus exposed. Finally, after 25 to 30 minutes' work, the mats are removed one by one from the bottom of the stream, folded in both directions under water to transfer the material to the middle, and then bent into the shape of a trough and "jugged" with a longitudinal motion under the water to separate the lighter sand and gravel which still remains. One of the mats is then held in the stream, between the ankles of the gold-washer, and folded lengthwise as a trough, through which the water is allowed to flow quietly. A second mat is then seized by the ends, inverted and folded transversely, the fold being allowed to dip just below the water in the trough of the mat below. The mats are so woven that this folding opens the crevices between the large transverse strands, allowing the gold and iron-sand to be washed out by the water. By alternately raising each end of the mat while depressing the other, the whole surface is successively washed by the stream, and the various strands of the mat being opened and loosened by the folding, the gold and iron-sand are very completely transferred to the lower mat. In a similar way the concentrated material from all the mats is collected on one, and from this is finally transferred to the shallow wooden washing-board. This last transfer is made with great care in a quiet pool of water, in which place the final concentration on the board is effected. The separation of the gold from the iron-sand on this board requires great skill and caution. The board is first floated on the water, and by a few oscillations, the material is washed to the centre. Then it is raised from the water with a number of smart longitudinal jerks, the effect of which is to bring the heavier material to the end next the gold-washer, while the lighter sand flows off gradually with the water at the lower end. The board is now brought to the surface of the water, the lower end dipping a little below, and with one or two gentle swings, it is again covered with water, while a small quantity of the light sand is washed from the lower end. The board is then raised with the same dextrous shakes as before, the washing being conducted with great care, and but little iron-sand being allowed to pass off each time. After 5 or 6 minutes, most of the gold will have been brought to the head of the board, the light-yellow grains showing very distinctly in the black sand. The gold may be brought more clearly into view by allowing a little water to trickle down the inclined board, which washes off the black sand and leaves the gold exposed. The first portion of gold, with some of the adjoining iron-sand, being removed, the remaining sand is washed a few times, usually yielding one or two grains in addition. Finally, the gold, and the small quantity of iron-sand taken from the board at the same time, having been dried, is submitted to a careful separation by blowing, the iron-sand is carried off, and the gold remains ready for weighing. In this last separation, a small magnet is sometimes of assistance for removing the large grains of iron-sand, too heavy to be blown away.

KASHMIR.—There is reason to believe that gold used to be sought for in parts of Kashmir proper; but notices concerning it are very scanty. The 'Ain-i-Akbari' says that gold was found in a river called Padmatti, and at Puckely and Gulkut (? Gilgit), which came from the country of the Dards. The principal localities where gold-washing is carried on in the territory of the Raja of Kashmir are apparently situated in Ladak. Dr. Bellew mentions having seen an old deserted mine in auriferous sands at Kargil (34° 34′ N., 76° 10′ 30″ E.), which has been abandoned since some of the workers were killed by a portion falling in.

LADAK.—According to Cunningham (1854), gold-washing in the beds of the Indus and Shayock was carried on only by Mahomedans from Balti, as the Buddhists of Ladak had long been prohibited from the search, probably with the object of preventing their neglect of agriculture.

Lydekker recently visited a locality named Kio (34° N., 77° 18′ E.), on the Markha river, where operations were being vigorously carried on. The gold is believed to be derived from certain veins of yellow quartz, which are very abundant in the Carboniferous limestone of that neighbourhood. In Ladak, a common form of pickaxe used by the miners consists of the horn of the wild sheep (*Ovis Vignei*) tipped with iron; this is mounted in a wooden handle, and is said to be an efficient implement.

A remarkable method of obtaining gold, which was formerly, if not now, practised in these regions, is to peg down the skins of animals with the hair on them in the beds of auriferous streams. The hair, presumably set against the current, acts the part of the modern miner's blanket, arresting the small particles of gold, which can be collected by drying and shaking the skins. Thus, it is said, the gold was gathered at Puckely. And the same practice is reported to have been anciently in vogue in Savoy.

MALAY PENINSULA.—One of the earliest modern writers on the Malay Peninsula was Lieut. J. T. Newbold (1833–39). Describing the gold-mine at Battang Moring, on one of the many so-called Mounts Ophir [Gunong Ledang], he says the mine is situated on the flat marshy ground at the foot of the slope on which the Chinese house stands; in length it measures about 10 yd., by 4 in breadth, and 6 or 7 ft. in depth. It is filled with muddy water, which is drained off by a simple bamboo hydraulic apparatus, somewhat resembling the Indian *pukotah*. The miners descend for the purpose of digging out the metallic earth, by means of rude ladders formed of the notched trunks of trees. The process is extremely simple. Having dug out a quantity of the earth, which consists of coarse sand, greyish clay and white pebbles, among which crystals of quartz are found, and greenish stones, the miner places it in a shallow funnel-shaped vessel of wood, and carries it to a stream of water, conducted by 2 narrow channels close to the mine.

The water, falling from a height of about 1 ft., washes away the lighter earthy particles and clay, assisted by the rotatory motion of the miner's hand. This done, he carefully picks out the stones and other refuse too large for the water to carry off, whilst the gold-dust in minute portions, sinks to the narrow bottom of the vessel, from which it is extracted, carefully washed, and laid by to be made up into small bags each containing one *bongkal* (1½ oz. troy).

The gold of "Ophir," though small in quantity, is as fine as that of Pahang in quality, being estimated at 90 *touch*. The earth is probably the débris of the granite forming the summit, the white masses appearing to be felspar in a decomposed state; the crystals are quartz, and the small grains in the earth are also quartz. The Chinese showed Newbold a specimen of a stratum of clay of a greenish-grey colour, beneath which gold is never found. The Chinese affirm that one mine does not produce monthly more than 1 *tael* (1⅛ oz.) of gold. This is probably designedly underrated. A tribute is exacted from each individual of $1 (4*s.* 2*d.*) monthly for the privilege of mining here, by the petty Malay chiefs, who levy it in person every 2 months, and in reality are little better than banditti.

Newbold gives the following list on the authority of the head Chinese miner at Moung, as the names of the places around Mount Ophir (for the gold is always procured at the foot), where mines have been established:—Battang Moung, Kedanon, Rejang, Kaddam, Tanong, Pacedalum, Berinjin, Terring, Kayo Arro, Kamoyan, Jongi, Deddam, Poggi Baru, Chundagon, Ayer Kuning, and Ayer Chamhi. He was also informed that formerly nearly 1000 Chinese worked in these mines.

The gold of the Peninsula, according to Newbold's rough estimate, amounts to 19,800 oz. annually. It is chiefly got at Ulú Pahang, Tringanu, Kalantan, Johole, Gominchi, and Jellye; Reccan, Battang Moring, and other places at the foot of Mount Ophir. He says that Pahang is celebrated for the quantity and quality of its gold. From the jealousy of the chiefs, the mines have never been accessible to Europeans. Gray, a trader who crossed from Malacca to Pahang, ascertained that the gold-mines were about 1 month's pull from the village of Jellye up the river Braugh, one of the tributaries to the Pahang stream, and 40 days' pull from Pahang. The total produce of these mines exceeds 300 lb. troy, annually. Gold dust is found a short distance from the left bank of the river at Bukit [illegible]a, a low hill covered with forest, at the foot of which are gold-mines formerly worked by Malays, who were compelled to quit them through the exactions of the petty chiefs.

Capt. Hamilton (1727) speaks of lumps of gold weighing 5 or 6 oz. which he saw taken from the Pahang, and states that the natives do not dive below 3 fathoms, though most gold would be found in the deeper parts, which reach 10 fathoms.

The following account of the gold-mines at Chimendras was drawn up by Newbold from native information.

Bukit Chimendras is a hill situated at Gominchi, a territory subject to the Panghúlu of Johole, bordering on the eastern frontier of Naning. It is covered and surrounded by an uninhabited forest of great extent, intersected by numerous rivulets, which have their sources on the hill.

Veins of quartzose rock run over it at various depths (generally 12 to 20 ft.) below the surface, forming the matrix, in which the gold is found in small broken streaks. The rock is enclosed in a bed of white clay, indurated more or less, termed *napal.*

The method pursued by the Chinese and Malays for separating the metal from its matrix, resembles that adopted by the Hungarian miners, only that the process of amalgamation is not practised by the former for this purpose.

The Malay miners, as soon as the precise spot and minute have been determined by their diviners, Pawangs, or other charlatans supposed to be skilled in discovering the hidden treasures of the earth, commence clearing the ground of trees, brushwood, &c., and then proceed to remove the roots and vegetable soil, by means of *biliongs* and *chonkoles* (the Malayan adze and spade), until the bed of *napal* is laid bare. These implements are now put aside, and a heavy sort of iron crow-bar (*perjong*) is employed.

The first layer of *napal* is soft and whitish; the second has a reddish tint. The last is a black incrustation resembling brick in hardness, and hence called by the natives *tambikir quali;* this is commonly 2 fingers' breadth in thickness, and, being removed, discovers the white vein of rock, the matrix of the gold, and termed *beting.* It is generally between 3 and 4 ft. in diameter; underneath lies a bed of whitish earth, below which gold is never found.

The next process is that of breaking up the *beting*, for which purpose also the *perjong* is used. From the extreme hardness of the rock, this operation is very laborious and tedious. The coarse pieces are pounded in a sort of large mortar, cut from the quartz rock. The pulverized stone is then passed through sieves (*kisye*) of ratan, and carried in small baskets to a running stream, where the smaller stony particles are washed away, while the gold-dust, with the grosser pieces, sinks to the bottom of the conical vessel, in which it is subjected to the action of the stream.

The refuse is picked out, and the gold-dust is again carefully washed and collected in a coco-nut shell, or leaf of the *palas* tree (*Butea frondosa*), and conveyed to the *bongsal*, where it is dried by means of a red-hot piece of charcoal being repeatedly passed over its surface. After the adherent finer particles of the sand have been removed, it is weighed into quantities, generally of 1 *tael* (1⅛ oz.) each, which are carefully folded up in small pieces of cloth. These packets constitute the *bongkals* of commerce, which are frequently current instead of coin.

Besides Chimendras and Taon, Newbold did not hear of any place on the Peninsula where gold is obtained from the solid rock. At Pahang and Jellye, the gold-dust is procured in the same manner as that in the mines at the foot of Mount Ophir. The mines at Reccan are estimated to produce annually about 20 *catties* (60 lb. troy) of gold-dust.

The Panghúlu of Gominchi first levied a tenth on the produce of these mines; but in consequence of large quantities of gold-dust being secretly carried off before the tenth had been levied, he substituted a sort of poll-tax, amounting to a *miam* (52 gr.) of gold per annum, from each person working at the mines. The Panghúlu of Johole is in the habit of sending 5 or 6 buffaloes a year to the mines, receiving for every head of cattle 2 *taels* (2¼ oz.) of gold. These heavy drawbacks have caused the mines to become unprofitable to the speculators, and almost deserted.

The former of these imposts could readily be endured; but the latter exaction destroys all hope of reasonable profit.

The following is an estimate of the various degrees of purity of gold-dust produced in the Peninsula. It will be necessary to premise that *mutu* is a term denoting the degrees of fineness for gold, of which there are 10, as fixed by the native assayers. Gold of 10 *mutu* is equal, therefore, to gold of 24 carats; gold not reaching 8 *mutu* is called *mas muda* ["young gold"]; and gold from 8 to 10 *mutu*, *mas tuah* ["old gold"]:—

Gold of Reccan	9½	*mutu.*
Mount Ophir	9¼	,,
Chimendras and Taon	9½	,,
Pahang Jellye Tringanu Kalantan	9¼	,,

From Kalantan, gold of 10 *mutu* is sometimes obtained.

The assayers of gold are generally Chuliahs or Klings, who acquire by constant practice the power of determining to the fraction of a *mutu* the purity of any specimen of gold-dust. As they would be perhaps liable to imposition were this the only trial to which they subjected the metal, they have recourse to the *battu-uji* or touchstone. This is a roughish black stone, apparently basalt, brought from continental India, and generally set in a small frame of bronze or brass.

The assaying needles are commonly 20 to 24 in number, ranged on a string, and alloyed in known proportions of copper and silver, marked on the surface, from 3 to 9¾ *mutu*. The needle and gold to be assayed are rubbed on the touchstone in parallel streaks in the usual manner; a lump of the adhesive wax called *lilin kalulut* is then applied to the surface of the touchstone, which brings off the two thin laminæ of gold.

The difference between the two is more visible on the wax (which is coloured black for this purpose with a fine charcoal made from the plantain-leaf) than on the stone. This is the reason the native assayers give for the removal of the streaks of gold from the stone to the wax, though to Newbold no difference was perceptible; possibly the following may better serve to explain the practice of the natives in this particular.

The impressions of gold, which would be lost on the stone, go on accumulating in the wax; a ball of it, which his native informant had used for the last 30 years, he supposed to contain above 2 *taels* (2¼ oz.) of gold. The metal is separated from the wax by means of heat, applied gradually, in such proportions as barely to cause the wax to pass off in the form of smoke; the residuum is then subjected to the process of amalgamation. Half the gold thus obtained is bestowed in alms upon the poor, or on religious offerings at the shrine of some favoured saint or *wali*, generally that of Miran Sahib, in Nagore, on the coast of Coromandel.

The calculation of a Malay, long employed in the mines at Chimendras, makes the average quantity of gold yielded from 40 lb. of the pulverized stone 24 gr. of pure metal. Lumps of virgin gold weighing 5 to 6 *taels* (5⅝ to 6¾ oz.) have been found in the alluvial soil here and at Taon. In Jellye, a mass weighing upwards of 1 *catty* (2·98 lb.) has been discovered.

According to Moor (1837), the territory of Pahang extends from Sadile in lat. 2° 15′ to Kamamang in lat. 4° 15′; the gold-yield amounts to about 2 *piculs* (266⅔ lb.) yearly. Tringanu, the next state on the E. coast, extends from Kamamang to the river Basut; its production of gold is considerable. Kalantan extends from the river Basut to that of Banara, and produces much gold. It is said there are 15,000 Chinese engaged in gold-mining in the above 3 states, and that they annually produce 420,000 Spanish dollars' worth.

Cameron (1865) records that a Capt. Playfair, when repairing a road at Malacca, discovered in a small recess which formed part of the old Portuguese Government buildings, 40 or 50 earthenware pots, mostly broken, but those which were whole were full of quicksilver, showing that gold was formerly largely obtained, to require so much quicksilver—over a ton weight. When gold was discovered in Australia, Europeans as well as Chinese spread themselves over the jungled valleys around Mount Ophir, with the hope of striking some rich lead. No such lead could be found; but it is worthy of remark that in almost every spot which was tried, gold in small quantities was procured.

Bickmore observes (1868) that in the Malay Peninsula, gold "has always been more highly valued than tin, and it is therefore, by all means probable that it was an article of commerce, and was exported to India as early as tin, or at least 500 years before Solomon commenced building his splendid temple."

Col. Yule (1875), after mentioning that gold is a staple export of Kalantan, Tringanu, and Pahang, notices that Barbosa says gold was so abundant in Malacca that it was reckoned by *bahars* of 4 cwt.; and though Logan has estimated the present produce of the whole Peninsula at only 20,000 oz., Hamilton, at the beginning of last century, says Pahang alone in some years exported above 8 cwt.

Leech (1880), speaking of the country drained by the tributaries on the E. (left) bank of the Perak river, says gold is known to exist in the Plus, being found with the stream tin. Tapa is the place of embarkation for a number of tin-mines worked by Chinese, where much gold is also found. Bidor is reached in 1 day's journey S.E. through the gold-fields. The gold is very pale, and of inferior quality.

Daly (1882), from a place called Klubi, surveyed a track, all through dense jungle, that led to the Chindrass gold-mines, near Mount Ophir. Here the Malays still wash out gold-dust excavated from gravel deposits; and they sink short shafts, out of which they get small blocks of stone, which they rudely crush with pestle and mortar, and wash out at a neighbouring stream. The deepest shaft was only 100 ft., and a lode had not yet been discovered. The gold is only found in detached leaders and saddles.

Gold was the principal metal met with by him in Pahang, though tin-mines similar to those in Selangor are worked with profit. The gold is found in alluvions, and washed out by Chinese and Malays in a rude manner. No attempt has yet been made to work gold in quartz, nor has any European machinery for either crushing or pumping purposes as yet been introduced. Daly was informed that there were 6000 Chinese working alluvial gold-mines in different parts of the interior. Some Chinamen whom he met said that they had to pay exorbitant royalties to petty rajahs in the far interior, and that they were so "squeezed" by successive rajahs on their way to the coast, that they derived but little profit from their hard-earned and risky labour. At that time, all the gold was supposed to be sold to the Bandaharah of Pahang, who paid a standard value according to his own estimation, or rather inclination.

MOLUCCAS.—The northern part of the island of Bachian is of sedimentary origin of various ages, and gold has been washed since 1774, according to Bickmore (1868).

PERSIA.—According to Strabo (B. xv. c. ii. § 14, Bohn's ed. iii. 128), Onesicritus says that a river in Carmania brings down gold-dust.

The mining engineer from Berlin, who was sent in 1877 to examine into the reported existence of a rich gold-vein at Zengan, found auriferous quartz, but no decided vein or deposit.

PHILIPPINES.—Pigafetta (1519–22) was informed by the king that gold was found in Mindanao in lumps as large as a walnut, and even as an egg, mingled with the earth, that they used a sieve for sifting it, and that all his vessels, and even many of the ornaments of his house, were of this metal. Sonnerat likewise speaks of Mindanao as an island abounding in gold. Pigafetta also believes gold to be abundant in Massana, from the light esteem in which it is held.

According to Bowring (1859), the gold of the Philippines is produced by washing and digging. In several of the provinces, it is found in the rivers, and natives are engaged in washing their deposits. The most remarkable and profitable of the gold-mines worked by the Indians are those of Tulbin and Suyuc. They break the rock with hammers, and crush it between two small millstones, washing the fragments in water, by which the gold is separated. They melt it in small shells, and it is worth generally $8 to 10 (33*s.* 4*d.* to 41*s.* 8*d.*) an oz., but its fineness seldom exceeds 16 carats. It is found in quartz, but the nuggets are rarely of any considerable size. The inhabitants of Caraga cut, in the top of a mountain, a basin of considerable size, and conduct water to it through canals made of the wild palm; they dig up the soil while the basin is filling, which is opened suddenly, and exhibits for working any existing stratification of gold; these operations are continued till the pits get filled with inroads of earth, when they are abandoned; generally, when a depth has been reached which produces the most advantageous returns, the rush of waters conveys away much of the metal which would otherwise be deposited and collected. Gold is also found in the alluvial deposits, which are ground between stones, thrown into water, and the metal sinks to the bottom. The rivers of Caraballo, Camarines, and Misamis, and the mountains of Caraga and Zebu, are the most productive. Many Indian families support themselves by washing the river sands, and in the time of heavy rains, gold is found in the streets of some of the *pueblos* when the floods have passed. There can be no doubt of the existence of much gold in the islands, but principally in the parts inhabited by the independent tribes. The Sociedad Exploradora was in Bowring's day engaged in working gold-mines and washing auriferous sands in the province of New Ecija. Gold-dust is the instrument of exchange in the interior of Mindanao, and is carried about in bags for the ordinary purposes of life. The Spaniards say that the province of Caraga (in Mindanao) is the richest of the Philippines; it is certainly one of the least explored. A Frenchman had been engaged in working the gold-mines; but Bowring did not learn with what success.

Jagor (1873), speaking of Longos, North Camarines, says that the soil is composed of rubbish, decomposed fragments of crystalline rock, rich in broken pieces of quartz. The workmen make holes in the ground 2½ ft. long, 2½ broad, and 20 ft. deep. At 3 ft. below the surface, the rock is generally found to contain gold, the value increasing down to 18 ft. of depth, and then again diminishing, though the proportions are very uncertain, and there is much fruitless search. The rock is carried out of the holes in baskets on ladders of bamboo, and the water in small pails; but in the rainy season, the holes cannot possibly be kept free from water, as they are situated on the slope of a mountain, and are filled quicker than they can be emptied. The want of apparatus for discharging water also accounts for the fact that the pits are not dug deeper. The breaking of the auriferous rock is effected with 2 stones, one of which serves as anvil, and the other as hammer. The former, which is slightly hollowed in the centre, is laid flat upon the ground; and the latter, 4 × 8 × 8 in. in dimensions, and therefore of about 25 lb. weight, is made fast with rattan to the top of a slender young tree, which lies in a sloping position in a fork, and at its opposite end is firmly fixed in the ground. The workman, with a jerk, forces the stone that serves for hammer down upon the auriferous rock, and allows it to be again carried upwards by the elasticity of the young tree. The rock is ground in an *arrastra*.

The washing-out of the mud (from the *arrastra*) is done by women. They kneel before a small wooden gutter filled with water up to the brim, and provided with boards, sloping downwards, in front of the space assigned to each woman; the gutter being cut out at these places in a corresponding manner, so that a very slender stream of water flows evenly across its whole breadth downwards over the board. With her hand, the workwoman distributes the auriferous mud over the board, which, at the lower edge, is provided with a cross piece; and, when the light sand is washed away, there remains a stratum consisting chiefly of iron, flint, and ore, which is taken up from time to time with a flat piece of board, and laid on one side; and at the end of the day's work, it is washed out in a flat wooden dish—*batea*—and for the last time in a coco-nut shell; when, if they are lucky, a fine, yellow dust shows itself on the edge. In only one out of several experiments made in the Berlin Mining College, did gold-sand contain 0·014 per cent. of gold; and, in one experiment on the heavy sand remaining on the mud-board, no gold was found.

During the last washing, the slimy juice of the *gogo* plant (*Entada Pursætha*) is added to the water, the fine, heavy sand remaining suspended therein for a longer time than in pure water, and thus being more easily separated from the gold-dust. It is further to be mentioned that the refuse from the pits is washed at the upper end of the water-gutter, so that the sand adhering to the stones intended for pounding may deposit its gold in the gutter or on the washing-board. In order to melt the gold thus obtained into a lump, in which form it is bought by the dealers, it is poured into a small heart-shell (*Cardium sp.*), and, after being covered with a handful of charcoal, placed in a potsherd, when a woman blows through a narrow bamboo cane on the kindled coals, and in one minute the work is completed. A small nugget obtained in this manner, tested at the Berlin Mining College, consisted of:—Gold, 77·4; silver, 19·0; iron, 0·5; flint earth, 3·0; loss, 0·1.

The result of many inquiries shows the profit per head to be on an average not more than 1½ r. daily. Further to the S.W. from here, on Mt. Malaguit, are seen the ruins of a Spanish Mining Co.; a heap of rubbish, a pit 50 ft. deep, a large house fallen to ruin, and a stream-work 4 ft. broad and 6 ft. high. The mountain consists of gneiss much decomposed, with quartz veins in the stream-work, with the exception of the bands of quartz, which are of almost pure clay earth with sand.

The gold is commonly 15 to 16 carats, worth about $12 (50*s.*) per oz.

In Mt. Dallas, gold was mined by a Spanish Co., and is still by the Indians. Gemelli Carreri was informed by the Governor of Manilla (in Morga's time) that gold to the value of $200,000 (40,000*l.*) was collected annually without the help of either fire or quicksilver, and that Paracali (N. Camarines) in particular, was rich in gold. The produce now is very small, as well on account of the incompleteness of the mode of procedure, as of the irregularity of labour.

RUSSIA IN ASIA.—The first discovery of gold in Russia was made in 1737, when a peasant named Taras Antonof came upon it near Voitsk, a village in the district of Kem, in the government of Archangel, not far from where the river Vyg flows out of the lake of the same name. The following year, the Imperial Senate issued an ukase or edict, allowing private persons to work the ore. Little, however, was done here, and the mine was abandoned in 1794, richer fields having in the meantime been opened farther east. Lured onward by reports of fabulous wealth, a band of Cossack adventurers, led by that "illustrious brigand" Yermak, laid the foundations of a new empire for the Czars beyond the Urals. But it was not till more than a century and a half later that the first-fruits of their exploit became apparent, and the mineral wealth of Siberia began to be developed. In 1745, 22 years after the foundation of Ekaterinburg, now the most important and thriving centre of the Ural mining industry, gold was found on the banks of the Beriozofsk, a tributary of the Isset, on which Ekaterinburg is situate. Between 1754 and 1847, upwards of a million tons' weight of ore-stuff were raised and washed at Beriozofsk, yielding 26,015 lb. of gold, in the proportion of 1 lb. of metal in 40 tons of ore, a result small as compared with other gold-fields in more distant parts of Siberia and elsewhere, but considerable when compared with the low cost of labour and the primitive machinery in use.

The rapid development of the gold-industry in Russia during the last 20 years has been due to a variety of causes. Amongst these have been the great demand that has sprung up in both hemispheres for the precious metal as a means of converting the currency, the very inadequate supply to meet the requirements of all those states desirous of placing their finances on a sound footing, and the immense importance to Russia herself of bringing into circulation the vast stores of wealth hidden beneath her tundras and forests. These considerations induced the Russian government to throw open to individual enterprise the gold-fields scattered over a vast territory. But in the earlier days, only a few privileged persons participated with the government in the industry. The Stroganofs, the Demidofs, and the Yakovlefs laid the foundations of the Russian mining industry, and earned by their immense wealth a world-wide reputation. Their ancestors, born of the humbler ranks, received grants from earlier Czars of extensive tracts, with exclusive rights over the minerals. The Demidofs were the first to take advantage of the permission, conceded only in 1859, to wash the alluvia; 442 lb. of gold were annually obtained by them between 1859–63, and as much more in the surrounding district. Neviansk too is remarkable for its leaning tower, said to have been erected by Yakovlef for smelting silver-ore obtained from his mines in the Altai—a process illegal in those days, and obliged to be conducted secretly.* Almost due south of Ekaterinburg, in the district of Zlataust (golden mouth), famed for its steel-cannon foundry and small-arms factory, in the government of Ufa, are the gold-fields of Miask, in the valley of the river Miass. The auriferous tract here extends over 1700 sq. *versts* (1060 sq. miles) and occupies a belt 100 *versts* (60 miles) long by 20 to 30 (12 to 18 miles) wide. It is bounded on the east by the Ilmen hills, a ridge running parallel with the Ural, of which it forms an arm, remarkable for a variety of rare minerals found among its rocks. On the south, some detached hills, connecting the Ilmen with the main axis of the range, form the water-parting between the head-waters of the Miass flowing north, and those of another tributary of the Tobol—the Ui—flowing south. Silurian limestones and schists, penetrated and in some places metamorphosed by granites, porphyries, serpentine, and other igneous rocks, characterize this region. The schists, both argillaceous and talcose, overlie granite and limestone rocks, and are veined with berezite and auriferous quartz. The limestone is in places raised and rent asunder by diorite and serpentine masses, and these mainly compose the valley of the Miass, and distinct ridges, such as Nurali, Kumatch and Aushkul, whilst the Ilmen hills are mostly formed of granite, containing many rare and beautiful minerals. Down the eastern slopes of the main axis of the Ural and the western slopes of the Ilmen, flow numerous tributary streams, all remarkably auriferous. The valley in which they meet is covered with superficial detritus rich in gold.

Miask became known towards the end of the eighteenth century, when Ilarion Ivanovitch Luginin erected smelting furnaces here, and called his works Petropavlofsk, after the two saints Peter and Paul, who have long been believed to watch over the destinies of Russia. In 1798, these works were transferred to Government, and the very next year gold was discovered and machinery erected to wash it. At first, operations were confined to quartz, and the quantity of gold obtained was insignificant; but in 1823, attention was drawn to alluvial deposits, and these produced 50 to 64 *puds* annually, or about a ton on an average. This gold-field was divided into squares, having each a superficies of 1 sq. *verst* (⅝ mile) and distinguished by a separate name. In 1863, 292 of these were worked, with the following results :—

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* The gold-fields of Ekaterinburg, as well as those of Miask, though on the Asiatic slope of the Ural, are included for administrative purposes in European Russia.

	1861.	1862.	1863.
Earth and sand washed	500,000 tons.	300,000 tons.	250,000 tons.
Workmen employed	1760	1801	1086
	cwt. lb.	cwt. lb.	cwt. lb.
Gold obtained	118 9	109 36	156 8

In 1876, the Miask gold-fields again became private property, and their productiveness largely increased. When passing through Ekaterinburg in 1880, the writer fell in with the managing director of the company working the Miask mines. He had with him a number of nuggets, the largest of which weighed within 5 *zolotniks* * of ½ lb. Some showed distinctly the crystallization of the gold, others again took curious shapes, giving them a value to collectors apart from their intrinsic worth. Each nugget was accompanied by an official document, issued by the department of mines in Ekaterinburg, describing its weight and appearance, and stating that the Government duty of 20 per cent. had been paid upon it. The Miask gold-fields produced in 1879, 130 *puds* (4680 lb.) of gold, proving that they fully maintain their reputation of being the richest in the Ural. These three of the principal localities in which gold is found in the Ural have been mentioned because the writer happens to have personally become acquainted with them; but there are many others to which allusion will be made in the sequel. Suffice it to say here that the whole eastern slope of the Ural, both north and south of Ekaterinburg, is generally auriferous; whilst the western slope, abounding in copper and other minerals, is destitute of gold. With this general remark, the reader is referred to the sequel for the most recent information that it has been possible to collect on the gold-production of Russia.

In the S.E. corner of the government of Tomsk, between 48° and 52½° N., and 80° and 90° E., on the confines of Western Siberia with the Chinese empire, lies the mountainous and picturesque region of Altai. With an area of 48,000 sq. miles, its vertical elevation averages 4000 to 4500 ft., whilst its passes often rise 1000 ft. higher, and the loftiest peak (Bieluha) attains 11,000 ft. above sea-level. In its mineral and vegetable wealth second to none, this tract may literally be termed a "golden region." Its very name, derived from the Mongol *altyn* ["gold"], and corresponding with its Chinese nomenclature In-shan ["golden mountains"], shows how universally its wealth was known.

The word *altai* with its variants *altyn*, *altun*, *altan*, *altangana*, &c., is generally indicative of gold in some form. The Tartar *altyn* found its way into Russian coinage, and represented the value of 3 *kopecks* silver* (about 1*d.*). An *altinnik* is 1 *kopeck*; a *piati-altin* (*lit.* fifth altin) is a vulgar name for a 15-*kopeck* coin. In Asia, *altyn* occupies a conspicuous place in the nomenclature of mountains, passes, &c. The great range of mountains discovered by Prjevalsky south of Lake Lob is entitled Altyn-tagh; the name is also applied to the Khingan range of the Chinese; and the writer fell in with it on his way to Kuldja, at the pass of Altyn Immel or "Golden Saddle," over which lies a good road across a long spur of the Semirétchian Ala-tau. The popular legend concerning it is that Jinghiz Khan's saddle is buried there. However this may be, it is probable that the rocks are auriferous. At all events, the writer came upon gold-impregnated reefs on the right bank of the Ili, not very far off, and specimens he broke off there were taken by General Kaufmann for analysis at Tashkend.

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* There are 96 *zolotniks* in the Russian lb., which is equal to 14 oz. 7 dr. Eng. avoirdupois. The Russian *pud*, or 40 lb. of that country, is consequently equal to 36 lb. 2 oz. Eng. avoirdupois, or say 36 lb.

Gold-mining in the Altai is no longer in its former prosperous condition. New and richer fields in the far east have attracted miners away, and the production of gold has fallen to about one-tenth of what it was some 20 years ago. The Altai mining district with its works, mines, gold-fields and *volosts* or communes of peasants, comprised in the districts of Barnaul and Bysk and the circuit of Tomsk, all in the government of this name, belong to the Imperial Cabinet, i. e. form part of the private estates of the Russian crown. They are under the supervision of the governor of Tomsk, who is also director-in-chief of the Altai mines, whilst an officer of mining engineers, residing at Barnaul, assumes the immediate control. The mining localities are situate in the Altai mountains, south of Barnaul, known as the Zméinogorsky† district, in the Salair ridge; and in the Kuznetsk Ala-tau, to the N. and N.W. of the town of Kuznetsk, separated by a wide low-lying plain, upon which, 380 ft. above the river Obi, stands the town of Barnaul, the administrative centre. The minerals are chiefly silver, lead, copper, and a little iron. The ore is smelted at one copper, five silver, and two iron works. Between 1745 and 1860, the production reached 4,176,000 lb. of silver; and between 1830, when auriferous alluvium was discovered, and 1860, 32,400 lb. of gold, with a total annual value of about 2,000,000 *rubles* (250,000*l.*), one-fourth of this, or 500,000 *rubles* (62,500*l.*), being credited to gold. These results were obtained at the cost of 830,000 *rubles* (103,750*l.*), besides the labour of 180,000 peasants, who discharged work at the mines instead of paying a capitation tax, estimated to produce 1,200,000 *rubles* (150,000*l.*) at 6½ *rubles* (16*s.* 3*d.*) per head.

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* "Silver" as distinguished from "banco": a "banco" *ruble*, now obsolete, was 2/7 of a silver *ruble*, and practically there is no such thing as a silver *ruble*.

† The first gold obtained from silver ore was run out at the Zméinogorsky works in 1745.

The gold-fields are situate along the western slopes of the Kuznetsk Ala-tau, and in the Salair ridge,* and are divided into the following groups:—(1) Salairskaia, on the rivers Berdi and Ini, including the Yegoriefsky, Salairsky, Ursky and Mungaisky workings; (2) Taidonskaia, on the Taidon, and northwards as far as Uspensky mine, in the Kuznetsk Ala-tau; (3) Tersinskaia, on the three Tersi rivers, affluents of the Tom, including the Tersinsky and Pezassky mines; (4) Miasskaia, on the Miass, a tributary of the Tom, with the Tsarevo-Nikolaiefsky mines; (5) Kondomskaia, on the Kondom, also a tributary of the Tom, with the Spassky mine, and (6) the group of workings on the river Lebed (Swan), an affluent of the Bi, north of lake Teletsky.

Mining enterprise in the Altai may be said to date from a very early period, when a people now completely lost sight of, but known to antiquarians under the names Chud or Chudak,† inhabited this region. Their copper and stone implements have been found; but with the use of iron, they appear to have been unacquainted. In 1723, a party of Demidof's miners prospecting for minerals came upon old Chud workings at the S.W. end of lake Kolivan, a discovery which led to the despatch of artizans and overseers from Neviansk. In 1726, the first works were established on the Loktefka, an affluent of the Aley, and were named Kolivansky. Soon afterwards, the famous Zméinogorsky silver-mine was discovered on the Zméiofka, a tributary of the Korboliha. In 1737, Demidof invited two foreigners, Christian and Junghals, to smelt ore and reported to his government on the result of his work. Eventually (in 1747) the Kolivan-Voskresensky works became the property of the Crown, and were placed under a director-in-chief appointed by Government. At the same time, certain villages were assigned to the works, and their inhabitants were compelled to labour, receiving in return commutation of the capitation tax. In 1830, alluvial auriferous deposits were discovered along the Fomiha, a tributary of the Suengu, belonging to the Upper Obi river system. From this time, private enterprise began to give a new impetus to gold-mining in Siberia. As will be seen presently, it has almost monopolized the production, except in a few places where Government continues its works. Before leaving the Altai, it may be worth mentioning that extensive coal-fields have been discovered there, which will ensure a future of great prosperity to this country, long after silver and gold are worked out.

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* The Salair ridge is not marked under this name on some maps (e. g. that issued to the officers of the Siberian Staff Corps, corrected to 1868). It is a low spur of the Altai thrown up in a N.W. direction into the circuits or *arrondissements* of Kuznetsk, Tomsk, and Barnaul. It divides the valley of the Tom from that of the Obi, and disappears altogether in the Barabinsk steppe. It is about 170 miles long and 40 wide, and resembles externally the Ural range, having more the character of an elevated plain with steep slopes on the N.E., and gentle gradients on the S.W., than a chain of hills. The Salair ridge presents some interesting features to the geologist, both in the rocks of which it is composed, representing three distinct formations, and in the fossils found in its coal-measures near Bachatsk.

† The popular application of the word is to a funny fellow, an eccentric person, &c.

Next to the Altai and marching with it on the S.W., the Semipalatinsk region claims attention. Hither, in the early part of the eighteenth century, Bukholtz led his Cossacks, ever the vanguard of Russian explorers. Advancing up the Irtish, he erected forts to protect his communications. Yamishevo, the chief of these fortified places, now a post station a few miles from the town of Semipalatinsk, was the rallying point of early Russian settlers in the new country. Bukholtz told the Kalmuks, in those days a powerful people, that he was commissioned to search for minerals, but that this need not interfere with the good relations subsisting between their respective states. His successor Likhariof was instructed to obtain accurate information about the gold of Yarkand, discover roads leading thither, and learn if possible what rivers joined the Daria (i. e. Amu-Daria) and entered the Aral Sea. Since then, various efforts have been made to develop the gold-fields, with but indifferent success. According to the official report of the Lieut. Governor of Semipalatinsk for 1878, gold was obtained in that year in 22 localities in his province.* The writer learned, however, that mining industry was generally very backward, the chief *entrepreneur*, Popoff, having lately died and left his affairs in an embarrassed state. Want of enterprise and technical knowledge are among the principal difficulties to be encountered, for Kirghiz labour is abundant and cheap, whilst transport may also be obtained throughout the steppe.

Western Turkestan, the latest of Russia's acquisitions in Asia, abounds in gold. From the earliest times recorded in history, Bokhara was renowned for its productiveness of this metal, and the Oxus throughout its course was said to be auriferous. But from experiments made by Russians, it appears doubtful if the gold of Turkestan can be successfully extracted. The Chinese, with their habitual skill and industry, made it pay; and when they were turned out of the country, the Sarts, a mixed Tadjik and Uzbek race of sedentary habits, following their example, took up the work of washing alluvial soil for gold, with results and in a manner to be described farther on. But Eastern people set a different value on time to that prevalent in Europe and the North American continent. The food they are content to live upon, their hours of labour, and the smallness of their earnings too, are wholly unsuited to the western European or even the Russian.

The gold-districts lie on both sides of the Semirétchian Ala-tau, as that chain of mountains is called which divides the lake country of Semirétchia from its chief river the Ili. Issuing by three sources from the mountains to the east of Lepsa, the Tentek flows a deep, rapid river over auriferous deposits. In his review of the Turkestan gold-fields, Tatarinof, a local geologist of eminence, says that the Chinese washed alluvium at Kizil-togoi,* near the sources of the Tentek, and it was plentifully scattered along the whole course of this river. But when Kuznetsof, the late well-known postal contractor and distiller of *vodka*, tried his luck at the diggings after the Chinese had been driven out, he invariably lost heavily. Thus, in 1868, he washed for gold at Kizil-togoi, obtaining only 4 lb. 44 *zolotniks* as the result of a summer's work, costing more than would purchase 20 lb. of gold. In the following year, 1869, he removed to Argaiti, and tried some extensive Chinese diggings, traces of which are still visible. Here he obtained in 100 *puds* (3600 lb.) of sand and gravel, a minimum of 30 gr. and a maximum of 98 gr., the whole produce of one summer's work amounting to only 1 lb. and a few *zolotniks*, with a considerable expenditure. These poor results obtained by Kuznetsof as compared with the success of the Chinese in the same localities, notwithstanding the low rate he paid for labour, indicate that the only way of working these gold-fields advantageously is to throw them open to all. In this way, numbers of the poorer class of natives would be attracted, who might earn a livelihood for themselves, and benefit the state by increased production of gold. By these means, and by sweeping away some irksome formalities, the desired end would be attained.

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* In 1865, according to Tatarinof, Semipalatinsk produced only 6½ lb. of gold.

In the Syr-Darian *oblast* or governorship, including southern and south-western Turkestan, the gold-question is even more doubtful than in the more northerly Semirétchian districts. Tatarinof says, "Hardly had our troops under Maj.-Gen. Chernaief, entered Kokand, than reports of its prodigious wealth flew from ear to ear." Sévertsef, the well-known geologist, who was present with the active forces in the field in the summer of 1864, was told of a gold-mine in Kokand on the Kukréú. Thither he repaired, and upon investigation, came to the conclusion that a whole system of alluvial deposits of gold were situate near the sources of the Tersi. Gold-miners rushed thither in quest of the El Dorado, and to the Chirchik, where it was reported that natives literally raked up the gold by the handful. All these stories proved to be highly coloured. Gold there certainly was, and men earned a living by getting it; but it was quite a mistake to suppose that it would pay the Russian miner to live in these countries, enduring all kinds of privations and hardships, in order to obtain an infinitesimal quantity of the precious metal, which is plentifully scattered over Siberia. But it was necessary to make a trial, and prospecting parties under the auspices of Kolesnikof, Pervushin, and Kulibin, visited the localities said to contain gold. They established the fact of the presence of gold on the river systems of the Chirchik, Talas, and Tersi, however thinly distributed. As to there being a system of alluvial deposits on the last-named of these rivers, that is doubtful, and it was a mistake to assert that placer-gold was found here. No doubt the locality is auriferous: so are the rivers in the Caucasus; yet not one has been found to yield enough gold to pay the expense of obtaining it. Auriferous tracts are alike as far as external characteristics go: the difference lies in the percentage of gold. Sévertsef mentioned having come across accumulations of sand, which had already been washed for gold, and contained on an average 1½ gr. in 100 *puds* (3600 lb.). But this proved nothing, because the process of washing employed by natives is of a rough and ready kind, the object being, not to obtain a large proportion of gold from a given quantity of soil, but that each man may do the best he can for himself. With more elaborate appliances, a still larger percentage of gold may be left in the sand after washing. The 1½ gr. in 100 *puds* may therefore either imply clean washing, for which natives are not in general remarkable, or, what is more probable, poor ore. When miners work for themselves in an unsystematic way, without taking into account the value of their labour, they can afford to wash very poor alluvium, containing probably but little more gold than the refuse they cast aside. Were the detritus rich, considerably more gold would be left in the sand after washing. But rich deposits have not yet been met with in Turkestan. Kolesnikof's miners penetrated in 1866 to the valley of the Chirchik, paying for their rash enterprise by the loss of one of their party, who was taken prisoner, and bringing back with them a few pieces of gold, the results obtained being so infinitesimal as to make it impossible to determine the percentage. Kulibin, an experienced gold-miner, himself director of gold-mining companies, and well acquainted with the gold-fields of Siberia, was also attracted by reports of fabulous wealth in Turkestan, and resolved to try his luck there, embarking a small capital in the enterprise. When on the point of leaving Turkestan for ever, after winding up his affairs, he was seen by Tatarinof, who asked how it had fared with him. Producing from his waistcoat-pocket a small bit of paper containing a little fine gold-dust, Kulibin said that was all he had obtained as the result of a summer's work on the Tersi. The writer's personal experience confirms this. One of his fellow-passengers, a mining *entrepreneur*, on board a steamer on the Irtish, gave a similar account of his attempts to work the gold-fields in the Kuldja region.

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* Kizil-togoi [tugai] signifies "red flat," doubtless an allusion to the bright-red colour of the sand on the banks of the Tentek.

Hence it would appear that no alluvial detritus worth working has been discovered in Turkestan, though experience was not wanting to guide the prospecting parties in their quest. Nevertheless, there is ground for belief that with greater energy, more perseverance, and additional capital, Turkestan may in the future become a gold-producing country. From the circumstance that the mountains which serve as a watershed between the Chirchik and the Tersi on the one side, and the Chirchik and the Talas on the other, are mainly composed of metamorphic schists, veined with diorite, syenite, and quartz of a yellowish colour, and that alluvial gold has been discovered along the Tersi and Chirchik, it is probable that the matrix is also to be found in these mountains. Owing to the extreme steepness of the fall in these river-valleys, as, for instance, for 180 miles of the Chirchik, from the mouth of its tributary the Kara Kispak to Tashkend, where the difference in level is 5000 ft., the detritus has not formed regular strata, but is scattered through the valley; many of the affluents of the Chirchik are even more abrupt in their courses, and in their valleys it is hopeless to search for gold. Some, however, particularly on the northern slope, are more gradual, and possibly contain beds of alluvium that may be advantageously worked.

Of the mining *entrepreneurs* who started to prospect for gold in Turkestan, Kolesnikof is the only one to persevere in the work. He is firmly convinced that he will be rewarded in time, arguing from the fact that gold occurs in all parts of the Chirchik, even at its mouth in the Syr-Daria at Chinaz, in such minute quantities, however, and so widely distributed, as not to repay the cost of obtaining. The cause of this is obvious: the native gold-rocks are situate far away from the mouth of the Chirchik, near its headwaters. The larger particles of gold swept down by the current, owing to greater specific weight, settle down in the upper parts of the valley; none but finer, lighter grains are carried down stream for a greater distance, and a little gold-dust is all that reaches the mouth of the Chirchik, or finds its way into the Syr-Daria, which may also be reckoned among the auriferous rivers of Turkestan.

Rich placer-gold is only found in localities where the incline is not too great, or where the current of a river slackens so as to form wide flats. In these places, gold may be deposited as sand or gravel, but there are few such on the Chirchik.

The Chirchik or Chatkal is one of the most picturesque valleys in the whole of Turkestan. In its lower part, it expands to considerable width, and is remarkably fertile. Here it is cut up by irrigation trenches, and is covered with vegetation, deservedly earning its name of "the Granary of Tashkend." Even in its lower course, the current is rapid, though nothing like its upper and central stream. Narrower parts of the Chirchik valley are full of huge erratic blocks, through which the river has cut a deep channel; these rocks have lain here for untold ages, and attest the comparatively far greater volume the river once had. Together with these disrupted masses, the Chirchik must likewise have borne along in its rapid current gold-detritus. This, as already noted (p. 374), was formerly worked by Chinese, and afterwards by Sart miners. Some of their workings were 700 ft. above the level of the river; and though obliged to carry water up this great height in vessels, they appear to have made it answer, and prosecuted the work assiduously.

Their system of washing differs from that of most countries, and may be said to possess originality, though of a primitive kind. In 1713, Prince Gagarin, then Governor of Siberia, reported at Moscow that gold was obtained in Little Bokhara by inhabitants of Yarkand, who caught it in blankets, carpets, and cloths.* The same method is continued by natives of Central Asia to the present day.

There are very many old gold-workings in the Chirchik valley, but none of them appears to have been particularly rich. However, it is impossible to say what may be contained in the lower strata until deep borings have been made. This has not yet been done, because wherever attempts were made to bore below the level of the river, work had to be discontinued, owing to flooding; and hand-pumps, the only available means of overcoming this difficulty, were wholly inadequate to get rid of the water.

Notwithstanding and despite of all these failures, Tatarinof is of opinion that the gold-industry of Turkestan has a future.

Yeniseisk Gold-fields. (*a*) *Northern system.*—The Yeniseisk gold-fields date only from the year 1832, when gold was discovered in the governmental circuit of Atchinsk, on the tributaries of the Chorny or Black Yuss, but in very small quantities. In 1835, alluvial washings were opened in the Minusinsk district, along the tributaries of the Tuba and Mana, the richest of all being on the Amila, an affluent of the Tuba. Exploring parties then crossed the watershed to the basin of the Biriussa, and discovered there in 1836 a rich stratum of auriferous alluvion on the river Horma. But the most remunerative of all the deposits in the Yenisei district were found in 1839, over a vast area between the rivers Yenisei, lower Angara, and Podkamenny Tungusska. The first-mentioned of these gold-fields, comprised in the Atchinsk and Minusinsk circuits, yielded, in 1861, 2872 lb. of gold in about 10½ million tons of ore-stuff, 62 workings being in actual operation on the Amila and Kezir, tributaries of the Tuba, on the Sisima and both the Yuss rivers. The next auriferous tract lies on the upper streams of the Kan and Agul; but this gold-field, being closely connected with that of Biriussa, will be treated of when speaking of the production in the government of Irkutsk, of which it properly forms part. The third and most important, that in the Yeniseisk district, produced, in 1861, 21,750 lb. of gold in 5¼ million tons of alluvium washed, or three-fifths of the total production of Eastern Siberia in that year. Some interesting particulars relating to this tract were supplied to the Russian Geographical Society by Latkin, who was himself engaged in this industry. From these, it appears that the region in question is divided into a northern and southern system, each of which comprises a wide extent of country. The northern Yeniseisk gold-system includes the whole area between 59° 15′ and 62° N., and between 87° 35′ and 96° 20′ E. of Greenwich. It is bounded on the N. and N.E. by the Podkamenny Tungusska, on the W. by the Yenisei, on the S. and S.W. by the Great Pit river, whilst on the E. it has no definite limits. This tract is for the most part very hilly, ridges of hills rising everywhere, though of no great elevation. Hoffmann found the highest point of the Chiriata ridge to be 2460 ft. above the level of the Yenisei at Yermak's residence, and a second peak, Kalaminskaya, 2495 ft.; but Latkin mentions other and higher points, such as Ponimba, on the summit of which, snow lies at the end of June, whilst in the deep clefts of this mountain it sometimes remains unthawed all the year round. These hills have no general direction, but may be described as independent groups, radiating from centres, containing the sources of many of the rivers, and often running parallel with the valleys. Another feature is the occurrence of isolated rounded cones standing apart from the ridge to which they presumably belong, forming welcome breaks in the scenery of the Yeniseisk gold-fields.

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* About the same time the Turkoman elder Hódja Neffez arrived from the eastern littoral of the Caspian, and told of the golden sand borne down by the waters of the Oxus.

The prevailing geological formations are metamorphic schists, more or less tilted; clay-slates predominate, and are characterized by large quantities of mica, with occasional crystals, sulphur-pyrites, hiastolite, hornblende, felspar, and quartz. Some of these slates have been so metamorphosed as to be micaceous, lying occasionally as independent belts, but are mostly associated with the clay. Granites, gneiss, more rarely red or grey sandstone, and limestone are the other rocks met with here. The auriferous deposits contain bismuth, magnetic iron-sand, and titanic iron, the last-named invariably found in all the washings. In some places garnets lend a reddish tinge to the detritus; in others again this is quite black, as on the Aktolik and Ogne rivulet. Bismuth occurs on the Sevaglikon. In general, the Northern Yeniseisk system differs but slighly from the Southern, save in the more frequent occurrence of gneiss rocks and limestone terraces, and a greater variety of crystals. In the group of mountains at the sources of the Veguda and Ponimba are the highest points in this district; mount Polkan, visible at a great distance, is the loftiest among them. Besides the Chiriata, three other groups of hills divide the several river-systems, and are also of considerable absolute elevation.

All rivers in the Northern Yeniseisk gold-field partake of the character of mountain torrents. In spring, after heavy rains, they rise suddenly, overflow their banks, and cause injury to the miners; in summer, many of the small ones dry up, and gold-washing has for a time to cease. But this rarely happens, losses more often resulting from floods than from scarcity of water.

The principal rivers are the Podkamenny Tungusska, with its tributaries the Chapa and Téya, its tributary the Yenashimo, the Great Pit, and lastly the Yenisei, the least important as far as gold is concerned, though receiving the drainage of the whole district. The Téya and its feeder the Yenashimo are the most auriferous rivers of the Northern Yeniseisk system.

The Téya rises by two sources in the before-mentioned mountain group; after receiving the Tirida on the right, it forms a good-sized river about 100 ft. in breadth, and, below its confluence with the Nogotá, it increases to 150 ft. or thereabouts. It is also joined by the Noiba, and two rivulets, the Bruce-Lanytch and Madura, together with other small brooks and streams, two of which are called Parni ("steaming springs"), because all the winter they remain unfrozen, and a cloud of steam hangs over them. Above the Nogotá, the Kurépa, by some considered to be the parent stream, is the largest left affluent of the Téya, while on the right below the Tirida it is joined by the Agdila, Nemchana, and lesser Ogne. About 7 miles below the mouth of the Noiba the Yenashimo joins the Téya, and some distance farther down the Jochimo, after which the now deep and navigable Téya falls into the Velme. The Téya has been little explored, and the gold, though distributed throughout its valley, is not worth working; it will therefore be unnecessary to speak further of it, beyond remarking that as far as it is known the principal formation is clay-slate, wholly unchanged in places, in others metamorphosed into mica-slate. On the heights separating the sources of the Nogotá from those of the Téya, as well as between this river and the Yenashimo, are beds of gneiss, containing quantities of mica and pierced by occasional veins of quartz. But since the Téya flows for about 100 miles of its course through the impenetrable *taiga*, where it is only known to natives, there are doubtless other formations common to the whole northern system, such as limestone and sandstone, especially as these rocks were observed by Hoffmann on Yermak's road, the first for several miles along the Téya, and near the mouths of the lesser Ogne, the latter near the mouth of the Noiba.

Hoffmann found the limestone on the Téya to be crystalline, also composed of thin layers, hard and brittle, of a light-grey colour, containing sometimes calcspar. This is quite the character of the limestone along the lesser Ogne, where it is found in large masses, filling the narrow valley with boulders and disrupted blocks, and contracting it into a defile near its mouth. The same kind of limestone is imbedded in the central and lower parts of the Noiba valley. The rivers Tungusska, Velme, and Téya, according to reliable reports, are navigable in flat-bottomed boats. The Noiba is about 27 miles long, and flows from the range dividing the valley of the Uvolga, a tributary of the Nogotá, from that of the Ollonokon, an affluent of the Chapa. The Noiba has also two sources, a right and a left one, the former being the longer and more auriferous of the two. It is joined too by numerous springs and dry gullies, two of which, the Doktorofsky and Kuznetsofsky, are remarkable. The width of the Noiba from the confluence of its head streams is 70 ft., and lower down 100 to 140 ft.; its general direction is N.N.E. In spring, it inundates its valley for some distance, at other seasons it is shallow; whilst in winter, remarkable ice-cones form in it, caused by springs which force their way to the surface. Its valley is 700 to 1000 ft. wide, but near the Riskofsky placer it flows between steep banks, and has hardly any level ground; towards its mouth the valley widens again to ⅓ mile. The first discovery of gold on the Noiba was made in 1842; but after several unsuccessful attempts to wash it, the placers were abandoned, and not re-opened till 1854, by Sidorof, and since 1861 they have been worked by Benardaki. The detritus on the Noiba in the upper and central parts of its valley is mostly clay-slate, wholly metamorphosed in places into mica-slate, having a strong resemblance to gneiss; many boulders, pieces of quartz, slate and limestone occur, however, in this part of the valley. Lower down, especially where it contracts, light-grey limestone is the prevailing formation; and, near its mouth, sandstone. Hence there are three distinct formations on the Noiba, which bisect it in a diagonal line from S.W. to N.E.

The auriferous stratum frequently lies in the bed of the river, or close alongside, with a breadth of 100 to 300 ft., and a thickness of 1 ft. 2 in. to 8 ft. It consists of greyish and reddish-brown or light-red clay, very friable (and therefore easily washed), with large quantities of stones. Between 1861 and 1865, the Benardakis obtained no less than 2700 lb. of gold, working 3 and 4 claims simultaneously; but notwithstanding the satisfactory yield, they were losers. At the other placers on the Noiba and its springs, 396 lb. of gold were taken up to 1865, making altogether 3096 lb. It is probable that a more careful and artistic mode of conducting operations would be remunerative; but no great development can take place here in the future, owing to the variable character of the detritus, and the difficulty in obtaining it. The worst in this respect, though at the same time the richest of these placers, is the Riskofsky; for the others are easier, and one in particular, owned by Benardaki, is convenient to work and constant in its production. The overlying peat varies in thickness from 7 to 14 ft., but rarely exceeds 10 ft. It is very full of stones, and consists of reddish-brown and light-grey rich clay, with fluviatile deposits. Some 400,000 tons of detritus have been washed at the Noiba diggings.

The Lesser Ogne, an insignificant rivulet, joins the Téya on the right, with a course about 5 miles long, remarkable for its steep fall and narrow valley. The Ogne was discovered in 1844, and two placer-mines were worked on it. One of these was remarkable for the depth and variable position of the drift, exceeding in some places 33 ft., under 14 ft. of peat; while in others, the peat lay directly upon the subsoil of the auriferous alluvium, which in such cases formed an extremely thin belt. In width, the detritus was between 35 and 100 ft., and consisted mostly of limestone, similar to that of the neighbouring hills. In substance it was adhesive, or, as the Siberians term it, "meaty," consisting of reddish and buff-coloured rich clay, full of fragments of limestone and quartz. The Ogne detritus was first worked in 1850, and abandoned, probably for ever, in 1861, after producing 2232 lb. of gold. The American system of working was tried here, but failed.

The other tributaries of the Téya are nearly all deficient in gold, with the exception of one small brook, which yielded about 36 lb. from 1856 to 1859.

The Chapa—a large tributary of the Velme—rises by two sources, in the range of hills separating the head-waters of the Gariofka and Tiss, in all probability a continuation of those which give birth to the Noiba. The Chapa has not been explored; of its feeders, the Ninchami, Chingasan, and Almanokon (with its tributary the Diubkosh), are the most remarkable. Nor has its detritus been thoroughly examined, so that the basin of the Chapa, its affluent the Chingasan excepted, is to this day a *terra incognita.*

The only auriferous deposits of any value hitherto found, are situated in the valley of the Chingasan, but here only on a spring which joins it on the left, not far from its confluence with the Chapa. In other places located by the gold-seekers, it proved only slightly auriferous; but even these were not fully explored, and now the basin of the Chapa is wholly abandoned by parties of gold-seekers, though there can be no doubt of gold being in other places besides that one spring. The Chingasan was discovered and claimed in 1842 and 1843, but work only began in 1847, and continued to 1853, to the extent above-mentioned at one mine. The total production was 541 lb. from 90,000 tons of sand washed.

The Yenashimo is the chief tributary of the Téya, and rises in the great watershed. Its general direction is from S. to N., and N.W. in its lower course, with an approximate length of 70 miles. On the right, it is joined by the Bezimianka ("nameless rivulet") and by the following auriferous brooks: the Lesser Gurakhta, Kalami, Ditin, Diubkosh, Ogne, Ollonokon, Greater and Lesser Kolichikana, besides numerous springs and gullies. Its left affluents are insignificant, and, with a single exception, not auriferous. The valley of the Yenashimo is almost 1000 yd. wide in places, whilst in others it narrows and forms rapids, as between the mouths of the Ditin and Diubkosh; the stream itself is 70 to 200 ft. broad, and 350 ft. lower down. The chief formations on the Yenashimo are clay and micaceous schists, with here and there, above and below the Kalami and Ditin, fragments of gneiss and granite; below the mouth of the Ogne, but only for a short distance, limestone rocks are met with; and towards the mouth of the Yenashimo, sandstones associated with grey, hard clay-schists. The detritus in the Yenashimo valley is very friable, but nowhere particularly rich in gold, except below the mouth of the Ogne. The average thickness of the alluvial deposit does not exceed 8 ft., and its breadth varies from 200 to 700 ft., though in places it reaches 1400 ft., for instance at Benardaki's mines. At the sources and in central parts of this river, as well as towards its mouth, the detritus is unproductive, variable, and, at its sources, lies in nests; but on the other hand, it is coarse-grained, and large pellets with small nuggets are frequent, though in other parts of the valley scarce. The detritus on the Yenashimo was first more thoroughly explored in 1851; in 1852 work was commenced, and up to 1864, at two of the principal placers, 12,420 lb. and 5430 lb. were produced respectively. The second of these, however, owned by Benardaki, resulted in heavy losses to this firm, who have the reputation of being the most enterprising and at the same time the most unfortunate in the Siberian mining world. At other diggings along the Yenashimo valley, 8804 lb. of precious metal were obtained up to 1864, in 24 claims, worked in different years, but within the same period, for a total quantity of 5 million tons of sand washed on the Yenashimo and its smaller tributaries.

Having as far as possible described the deposits in the valley of the Yenashimo, attention will now be given to its chief tributaries, which from the very beginning attracted the gold-seekers. The Kalami, the largest and richest of them, rises by two sources in the Sevaglikon-Aktolik watershed range. Its length is about 22 miles; its general direction from its sources is N.E. to S.W., then from S.E. to N.W., and finally, before it debouches, it takes a somewhat sudden turn to the W. Its valley, as far as the mouth of the Sevaglikon, is not over 700 ft. wide, but from this point to Ust Kalami mine, it is 2800 ft. in width, whilst towards its mouth it contracts considerably, and is not over 350 ft. The discovery of the Kalami detritus dates from 1840, and 2 years afterwards work was commenced. The Kalami is joined on the right by the

Nikolaiefsky spring, Sevaglikon rivulet, and Kuznetsofsky spring; on the left, by the greater Gurakhta, with scarcely any gold. The structure of the rocks and character of the detritus in the valley of the Kalami vary much. From its mouth to where the valley widens, gneiss predominates; beyond, are hard and highly metamorphosed clay-schists. From the embouchures of the Gurakhta and Sevaglikon, clay-schists give place to mica-schists, which afterwards prevail nearly the whole length of the Sevaglikon and Kalami valleys; whilst on the Gurakhta, with rare exceptions where clay-schists are exposed, red and grey-red granites, coarse-grained and composed of grey quartz, black mica and red felspar are seen. Belts of these granites lie not only along the Gurakhta, with its small feeder, but also across this river, and extend as far as the pass in the valley of the Eruda. Mica-schist, however, nowhere lies in continuous masses, but is associated with clay-schists, in which is also a quantity of mica. The layers of clay- and mica-schists, are often traversed by veins of white and yellowish quartz, which is particularly plentiful at the sources of the Kalami, as well as on the low ridge separating Nikolaiefsky and Danilofsky springs; fragments and boulders of quartz, however, are met with everywhere, and help to form the detritus. The subsoil of the Kalami valley consists of mica-clay or clay-schists, inclined at a steep angle, or standing in vertical ridges. In upper parts of the valley, the auriferous drift is from 2 ft. 4 in. to 7 ft. thick, and consists of yellowish and buff-coloured arenaceous clay, with a number of schistose and quartz pebbles imbedded in it; in central and lower parts, it is 4 ft. 8 in. to 8 ft. thick (though sometimes, especially on the hill-slopes, it does not exceed 3 ft.), and is composed of grey argillaceous sand, with a greenish tinge, very friable and easily washed, and also containing many boulders, fragments and pebbles of quartz, and, near the mouth of the Gurakhta, granite. The nearer this débris lies to the mouth of the Kalami, the more gneiss it contains. Some of the granitic and quartz blocks attain great size near the embouchure of the Gurakhta, and many of the latter are veined with gold. The peat strata too vary in thickness from 2 ft. 4 in. to 9 ft. 4 in., being thinner in the upper valley and thicker towards the mouth. In width, the alluvial deposits on the Kalami correspond with its valley,—in the higher parts, 70 to 210 ft.; along Nikolaiefsky spring, up to 350 ft.; whilst below the mouth of the Gurakhta, 1000 to 2000 ft. and upwards. Here the productiveness is much less than in the central parts, where, particularly near the mouth of the Sevaglikon, the richness of the ore-stuff was remarkable. The same thing occurs on the upper valley, where the yield is much greater towards the sources than lower down. Of all the placers on the Kalami, the Narkizofsky, owned by the Zotofs, is pre-eminent, as well for the width of the débris, as for the extent of the works. Here, up to 1864, 14,760 lb.

of gold were obtained. Another highly productive digging was the Nikolaiefsky, on the spring of the same name, worked by the Golubkofs, which had yielded up to the same year, 10,735 lb.; and a third, the Viktorofsky, belonging to the Basilefskys, from which 14,580 lb. were taken. The other placers on the Kalami were of less importance. At all the 19 mines in this valley, exclusive of those on the Sevaglikon, 59,508 lb. of gold were obtained from 8 million tons of sand washed, between 1842 and 1864. Work, however, still continued down to the date of Latkin's article (1869), and 5 placers were then in operation. The insignificant Sevaglikon, a right tributary of the Kalami, is one of the richest in this gold-producing country. It flows from the N.W. side of the Sevaglikon watershed range, with a general N.E. to S.W. direction, and a length of 8 miles. A small nameless rivulet and two auriferous brooks join it on the right, whilst on the left two small streams swell its waters. Its geology and detritus are nearly the same as those on the Kalami. But the richest débris begins from the point where a dry ravine opens into its valley. Higher up, the detritus is generally poor. Gold too was found on the sloping flank of a hill on its left bank, where huge lumps of white and yellowish quartz are seen in great numbers. This was the site of the once famous mines of Solovief and Rézanof. The detritus on the Sevaglikon was discovered in 1840 by Prehn and Jmaief, agents for two firms of *entrepreneurs*. In 1841, work was commenced, and though much of the drift is exhausted and worked out, it still continues to be remunerative, and there are doubtless yet undeveloped sources, an instance in point having recently occurred at the placer of Basilefsky and Malievinsky. Among the rarer treasures, mention should not be omitted of a greenstone hammer found in the detritus at the head of the above-mentioned dry ravine. And it is worth noticing that the auriferous stratum, composed of arenaceous buff-coloured clay, 2 ft. 4 in. to 3 ft. 6 in. thick, lies very near the surface, having only 2 to 3 ft. of soil above it, and extends in an almost imperceptible depression to the crest of the Sevaglikon dividing ridge, one of the works being actually on the ridge.* This remarkable high position of the auriferous alluvium is unique in the *taiga*, if the Preobrajénie mine, owned by Karpinsky, also on a dry ravine opening on the right into the Yenashimo valley, 1 mile below the mouth of the Ogne, be not a similar instance, though on a smaller scale. However, as only 36 lb. in all of precious metal were obtained here, it may probably have been a cavity or "nest" of ore derived from the breaking up of a vein of quartz, an abundance of which, in large blocks too, is met with. The most remarkable of the mines on the Sevaglikon were those of the Zotofs, which produced up to 1864, 34,920 lb. of gold; and in some years, as much as 3600 lb. were taken in the course of the summer. Next to these stood the Otradny, with 21,960 lb. obtained between 1841 and 1856. From 1856 to 1864, this placer was not worked, under the supposition that it was exhausted. But in 1864, new beds of detritus were discovered, with a rich yield of gold, and in that year 360 lb. were washed with 80 labourers. Solovief's placer produced 15,840 lb. up to 1864, when it was abandoned. At Golubkof's, 10,008 lb. were obtained between 1843 and 1864; at Rézanof's, now closed, 6480 lb. from 1845 to 1852; at Krasilnikof's, 14,256 lb. from 1843 to 1863; and at all the placers in the Sevaglikon valley, 119,268 lb. for about 10 million tons of detritus washed. Reckoning the nett value of the gold, exclusive of taxes and rates, at 10,500 *rubles* per 36 lb., the total amount obtained by the miners in the Sevaglikon valley was 40,000,000 *rubles* (say 5,000,000*l.*).

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* Cf. Murchison's 'Geology of the Ural,' vol. i. p. 489.

One mile below the estuary of the Kalami, the Yenashimo is joined by the Ditin, and 7 miles lower down by the Diubkosh. Both these streams flow from the Chiriata ridge with a general direction of N.E. to S.W., and courses of 13 miles and 10 miles respectively. Their tributaries are insignificant and their valleys of nearly equal breadth, under 700 ft. in the higher, and 1000 ft. in their central and lower parts, whilst the Ditin contracts towards its mouth to form a rocky glen. Their geology and detritus, as well as those of the surrounding hills and the Chiriata range, are nearly identical,—clay-schists, black in colour. In their lower valleys, however, these schists, in the case of the former, become gneiss; and in the Diubkosh valley, below the first spring, reddish-grey granite, loose and apparently weather-worn. At the sources of these streams and along the tributary springs, boulders of white and yellow, oily quartz full of mica are found in large numbers; but the schists are somewhat metamorphosed, and have become porous, and crystals of sulphur-pyrites and hiastolite occur in them, together with small fragments of talc-schist. The alluvium is generally stony, and consists of sandy clays of various shades, with numerous fragments of quartz and schists imbedded in them. On the Ditin, some of the clay is compact, and rich yellowish-grey and red in colour. Neither of these rivulets is particularly auriferous, and they have never been worked on a large scale, except at the placers of Shestof and Astashof. The detritus is between 150 and 350 ft. wide, 5 to 7 ft. deep, and overlaid by peat 12 to 14 ft. in thickness. Up to 1864, the placers yielded 4608 lb. of gold obtained on the Ditin, and 6408 lb. on the Diubkosh, for 2,150,000 tons of ore-stuff washed. At present, they produce on a more moderate scale.

The Ogne, another affluent of the Yenashimo, rises in the spurs of the Chiriata range, between the sources of the Diubkosh and Ollonokon. Its direction is at first N.W. and afterwards S.W.; its length is about 11 miles. It is joined by two or three brooks and springs on the right and left, the Ogne itself having two sources. The formations are clay-schists; but from the mouth of Sosulinsky spring to the estuary of the Ogne, white and light-grey, hard and brittle limestone is the characteristic rock. This limestone, which is destitute of fossils, occasionally lies in horizontal beds, but is mostly inclined at angles of 25° to 55°. It crosses the Ogne in a slanting direction, and, not far from its mouth, passes into the Yenashimo valley, here much pent up by hills. Cliffs, huge boulders, and fragments of it close the entrance to the Tukolonghi valley, and form a bit of wild, picturesque scenery. In upper parts of the Ogne and along its tributary brooks, quartz in boulders and fragments is so plentiful that whole beds of various colours occur, and the most auriferous detritus is full of it. At Gavrilof placer, the tailings composed of black magnetic iron-sand contain not unfrequently crystals of garnet and zircon. This gold is coarse-grained, in round pellets of high specific weight, and very free from alloy. Occasional pieces of it weigh upwards of 1 lb., and the quartz contains gold in crystals, veins, and sprays. On the whole, the Ogne detritus was highly auriferous, easily worked, and unusually thick, measuring at one placer—the Gavrilof—70 ft. with a breadth of 700 ft., whilst in other parts the width was between 140 and 350 ft., and from 4 ft. 8 in. to 7 ft. thick. This remarkable depression at the Gavrilof mine is almost worked out, though it is said that a layer 14 ft. thick still remains, but not so rich; most of the detritus on the Ogne is now nearly exhausted, though not long ago, upwards of 1000 men were employed at the Gavrilof placer, and 3600 lb. of gold were obtained during the summer. The Ogne detritus was first worked in 1845, and in 1851 it yielded largely. Up to 1864, the Gavrilof placer produced 27,720 lb.; and the total quantity during the whole time at 10 placers amounted to 49,788 lb. for 7½ million tons washed. At present only 3 mines are worked, though some of those closed might even now prove remunerative.

The Ollonokon rivulet flows into the Yenashimo on the right, 8 miles below the Ogne. It rises in the same range of hills, and its general direction is from N.E. to S.W., with a course 12 miles long. Its valley is between 700 and 1000 ft. wide. The formations are mostly metamorphic clay-schists, hard, black, and in places micaceous. Among the schistous débris are crystals of sulphur-pyrites, hiastolite, and quartz. At the mouth of the river, the detritus is only 140 ft. wide; but higher up, it expands to 350 ft. and upwards, with an average thickness of 7 ft. under peat 8 to 10 ft. thick. The alluvium is compact clay, very rich in places, though not to be compared with the neighbouring Ogne. The Ollonokon was discovered in 1841, first worked in 1845, and is at present abandoned, though some of the placers might still be profitably worked. The total yield of gold at 6 diggings was 5764 lb. for 800,000 tons of ore-stuff washed. The other tributaries of the Yenashimo are of no importance to the gold-industry, with the exception of one spring, which produced 337 lb. of the precious metal in 43,000 tons of detritus. In concluding this description of the Yenashimo basin, it is worth mentioning that in some of its detritus, fossil remains of mammoth and rhinoceros have been found, and they would perhaps be less rare were the overseers and labourers at the mines acquainted with them.

Of the other tributaries of the Téya, which are nearly all up to the present time in no way remarkable, allusion will only be made to the more auriferous, for instance the Jochimo, which rises on the N.W. slope of the range serving as a watershed to the Great Pit and Velme rivers. The Jochimo, though not inferior in size to the Yenashimo, has not hitherto attracted miners. Its left tributary, the Nemunia, receives the waters of the Dulijmo, with a little gold, and the Koto, with more, but so thinly distributed and under such masses of peat as to be considered unremunerative. The formations on the Koto and surrounding hills are clay-schists.

The Olinchimo, a left affluent of the Téya, was discovered by a party of Grigorof's gold-seekers in 1857. As soon as it became known that gold had been found on it, miners rushed thither, and soon claimed the whole river; but they were disappointed, and, with the exception of Grigorof, who for some time worked his claim, they soon abandoned it. The Olinchimo, however, is doubtless more auriferous than either of the two preceding rivers; but its distance from the Yenashimo diggings—some 50 miles or more—the want of roads, and the dearness of supplies, stopped explorations and work. It is even probable that Grigorof has discontinued work, though this is not certain. In 1861, he obtained 351 lb. of gold, with an average yield of 79 gr. in 100 *puds* (3600 lb.), for 70,000 tons of sand washed.

Having considered the system of the Podkamenny Tungusska, or rather of the Téya, attention will now be turned to that of the Great Pit, only the right side of which belongs to the northern Yeniseisk system. The sources of the Great Pit are not accurately known, but probably, as the Tungusses say, they are not far from those of the Podkamenny Tungusska and of the Velme. The length of the Pit is between 200 and 270 miles, according to the various computations, for nothing is known positively of its upper course, and the miners' maps are very inaccurate. Of the right affluents of the Great Pit within the northern system, those only will be mentioned here which from their length or some other feature are important. Such are the Chirimba, the Tavrikul, 23 miles lower down, the Ponimba, 3 miles farther, the Veguda, the Brianka, the Lendakha, the Lesser and Greater Kaitba, the Yalami, the Kamenka, and the Tocnilny, remarkable for its coarse-grained red sandstone, of which indifferent grindstones and whetstones are made.

The rivulet Chirimba, or rather the river, flows from the great dividing-range with a direction at first from S.E. to N.W., then S.W. to N.E., and, after receiving its chief tributary the Vangasha, N.W. to S.E. On the right, the Chirimba is joined by the Eruda, a stream of considerable size, though deficient in gold; then by the Vangasha, the most auriferous of its feeders; and afterwards by the brooks Tavrik, Pedun, Morok, and Kogai or Trinity spring, where red sandstone crops up. On the left, the small but a little auriferous Kalmir and others unite with the Chirimba. Clay-slates are the dominant formation in these valleys and on the surrounding hills, though in many places, especially below the Vangasha, boulders and fragments of granite, similar to that on the Gurakhta, are met with. In all probability, were these valleys better explored, more granite would be seen, especially as the granitic Ayaktinsky ridge crosses the Pit at the mouth of the Ayakta, and continues between the Chirimba and Tavrikul. Outcrops of these rocks have also been noticed on the Kadra, an affluent of the Ponimba, and many springs flowing into the Chirimba on the right, blocks and fragments of it filling some of their valleys.

The valley of the Chirimba is nearly everywhere upwards of 700 ft. wide, and widens in places to 500 yd. Meadow-land abounds, whence the gold-miners derive their supplies of hay. The river channel is about 150 ft. wide to the mouth of the Vangasha, and twice this lower down; yet the Chirimba is shallower than its tributaries the Eruda and Vangasha. Gold is feebly distributed in the valley of the Chirimba, though it is impossible to say what further explorations may produce there and in the Eruda valley. The Vangasha, a right tributary of the Chirimba, rises on the eastern slope of a spur of hills detached from the Chiriata range, and has a general direction from N. to S. It receives on the right the Uksigli, then the celebrated Aktolik, and below this the Kokoko, Shevandak, Akchedil, Akchelik, with many other smaller streams. Its left tributaries are insignificant, and so little auriferous that they may be passed over. The Vangasha is only 100 ft. wide as far as the mouths of the Shevandak and Kogni, but the nearer to its estuary, the wider it becomes, attaining a breadth of more than 200 ft. in places. Deeper than the Chirimba, it is nevertheless fordable everywhere in summer, but not in spring, when it inundates its valley. Like most of the *taiga* rivers, the Vangasha has a winding course. The detritus in its valley, which is throughout wide, consists for the most part of clay-slate,—friable, and therefore easily washed. In the lower beds of alluvium, the slates stand edgewise, and most of the gold is found between their flakes and in fissures. Round lumps of brown iron ore occur among the débris, but auriferous quartz is more rare than on the Aktolik, Ogne, and Kalami. The deposits and overlying peat are of the usual depth,—5 to 8 ft. in the former case, 6 to

10 ft. in the latter, with a breadth of 700 to 1400 ft. This detritus was discovered in 1839 by the Zotofs, but not worked till 1847. In all probability, the Vangasha valley derives its gold from the Aktolik, for above the confluence of these streams not a placer has been opened, and a few miles below this point the detritus was not found worth working, and only became richer close to the Aktolik. Nine placers were worked in the valley of the Vangasha; of these, the richest was owned by the Princess Madatova, and rented by her to Mme. Rodstvennaia, who obtained a good deal of gold here in 1865–66. Another, belonging to the Golubkofs, was one of the largest in the northern system; whilst the Uspensky of the Astashofs was one of the best. At the first of these, 2880 lb. of gold were produced between the years 1864 and 1867; at the second, 21,276 lb. from 1849 to 1864; and at the third, 1165 lb. from 1850 to 1858. All the other placers yielded together, up to 1865, 5973 lb.

The Aktolik, an affluent of the Vangasha, rises from two sources in the Sevaglikon dividing ridge, one flowing down the N.W. flank, the other the S.W. of this range. From their confluence, the Aktolik flows S.E., its length being less than 9 miles. The detritus is again of the clay-schistose nature so prevalent in these gold-fields; on its left source, however, are mica-schists pierced by veins of white quartz and felspar, inclined steeply to the N.W., whereas on the right source they dip to the S.W.; in central parts of the valley, hard clay-schists prevail, without a t[illegible] of mica. The alluvium (4 to 6 ft. thick) is argillaceous greensand, tole[illegible] compact, and full of schistose fragments and boulders mixed with quartz, and overlaid by peaty deposits. Almost exactly similar is the detritus on the left source, except that here a yellowish oily quartz encrusted with gold is met with. In lower parts of the valley, the alluvium is greenish sandy clay, also mixed with quartz and clay-schists 5 to 7 ft. thick, under peat 7 to 12 ft. thick. The Aktolik auriferous beds were discovered by Zotof's gold-seekers in 1839. Since 1841, they have been worked at 11 placers; the richest of these, if not in the whole of Siberia, was the Platonof mine, belonging to the Golubkofs. Between 1841 and 1864, 40,788 lb. of gold were produced here, the average yield being 11 *zolotniks* (724 gr.), though, in parts of the detritus, it was 1 lb. and even more of precious metal in 100 *puds* (3600 lb.) of sand. In 1847–48–49, large works were conducted here, employing between 1500 and 2000 men; the quantity washed in each of these years being 5976 lb., 7848 lb., and 6120 lb. In 1857, the quantity again rose to 4725 lb.; but the Platonof placer is nearly worked out, and in 1862 the work had dwindled to very small proportions, 288 lb. of gold only having been extracted in that year. Second to the Platonof in the richness of its detritus and yield of gold, was the Olga placer, owned by Basilefsky and Malievinsky, on both sources of the Aktolik. The largest production in any one year was 3420 lb. in 1849, and the total from 1845 to 1864 was 13,280 lb. A third remarkably auriferous placer was the Constantinofsky of the Zotofs, which yielded 25,712 lb. between 1841 and 1864. A fourth, Solovief's Holy-Trinity placer, produced 6255 lb. between 1843 and 1864. Altogether, 95,724 lb. of gold were washed on the Aktolik up to 1864, out of 6½ million tons of sand, clay, and detritus. For this quantity, after deducting rates and taxes, and assuming the value at 10,500 *rubles* per 36 lb., the mining proprietors should have received 27,920,000 *rubles* (3,490,000*l.*), and of this, Golubkof's share would have been 11,896,000 *rubles* (1,487,000*l.*). Of other streams in the Pit basin, the Ponimba, Tavrikul, and Veguda are the principal, but no rich alluvium has been hitherto discovered in their valleys. Three small placers were worked on the Tavrikul by Benardaki, Chernosvitof, and Isaief, but they produced altogether only 396 lb. of gold from 1861 to 1865. Blasting was necessary here to remove encumbering masses of metamorphic schists, closely resembling gneiss, and boulders of quartz and granite. The detritus, however, proved poor and unremunerative. The other placers on the Tavrikul have now been completely worked out, and give no hopes for the future.

The Ponimba, 70 miles long, receives the Kadra and numerous smaller brooks and springs, and flows through a valley much hemmed in by hills in a general S.E. and S.S.E. direction. Gold was only found at the sources of the tributary streams, where the detritus lies in a narrow belt 30 to 100 ft. in width, and 4 to 8 ft. in depth. Work commenced here lately on an insignificant scale; and the poorness of the yield, combined with dear labour, made it improbable that any extensions would follow. The Kamero, an affluent of the Veguda, is also auriferous; but here too the alluvium is narrow, variable, and below the average, yielding only 30 to 40 gr. Altogether the diggings on the Ponimba, its tributaries, and the Kamero yielded, to 1864, 432 lb. The other right affluents of the Great Pit are in no way remarkable, and require no further mention.

The Yenisei is joined by a number of rivulets and springs flowing from the northern gold-field, but it will be only necessary to name a few of the more important. Descending this river from the estuary of the Great Pit, the large stream of the Ki, with its affluent the Séverny [northern], flows into it; lower down, near the residence of Lopatin's Co., the unimportant Viatka; below the village of Nazimof, near the residences of various companies known under the name of Yermak, the Tiss, along the bank of which lies Yermak's road to the northern gold-field; beyond, the Gariofka and Otroikha. All these have been hitherto little explored, except the Tiss and Gariofka.

From Hoffmann's descriptions, gneiss rocks are seen along the Tiss for about 30 miles from its mouth, then red and lighter-coloured sandstone conglomerate with a mottled appearance; 20 miles farther, gneiss again reappears, with a dip of 30° N.E., containing felspar, hornblende, quartz, and mica. These outcrops also occur on the Volokovo, where clay-slate predominates; whilst on the Nogatá, tributary of the Téya, he found fine-grained greenstone. The Tiss is 700 ft. wide in one part; its banks are marshy, though not without meadow-land. The Gariofka has been only recently thoroughly examined, though discovered as far back as 1843, without, however, leading to any important results. At one mine only has gold been obtained in any quantity, viz. at the Voskresensky mine of the merchant Chechurof. This yielded 998 lb. between 1858 and 1864. The remaining placers on this river produced 79 lb. altogether.

The climate of the northern system is rigorous; winter continues for 7 months, and frosts are extremely severe for days together. The coldest months are November, December, January, and February; the hottest, June and July. Sledge travelling sometimes begins at the end of September, or early in October, and towards the end of this month the rivers are congealed. In the beginning of winter, snowstorms are of common occurrence, and continue for days together, obliterating roads and stopping communications between the mines. The first thaws begin in April, but the snow does not disappear before the beginning of May, and on the higher hills not before June, whilst on some of the highest it remains unmelted up to the end of this month. Regular summer weather begins early in June, and continues to the middle of August. Rainless summers are not unfrequent, whilst there are years when it rains incessantly all summer through. In winter, snow lies 5 ft. thick on the ground, and in parts of the forest drifts to a depth of 8 ft.

The natives are Tungusses of nomadizing habits. Their type is more distinctly Mongolian than farther south, though even here signs of intermixture with Russians are becoming evident. It is uncertain how numerous they may be, for they are so continually moving that no census can be taken. But disease and the extinction of furred animals are diminishing their numbers, and obliging them to seek more northern regions. Their encampments are often to be seen on the *taiga*, sometimes close to the mines, or wherever reindeer-moss is abundant. A few serve as guides to the gold-seekers. One well-known character, Anton by name, now in the receipt of a pension, led to the discovery of the rich placer-gold on the Sevaglikon and Aktolik.

Roads and ways of communication in the northern Yeniseisk gold-field are bad, owing to the unsystematic way of repairing them by the miners; and notwithstanding the larger yield of gold and greater number of hands employed, they are much worse than those in the southern system. The principal road to the diggings from inhabited centres is that which starts from the village of Lifantieva, on the right bank of the

Yenisei, opposite the town of Yeniseisk. It was made recently, and is available for wheel-traffic throughout, though the risk of a breakdown may be anticipated. The old road from Lifantieva may also be driven over for 30 miles; then it is necessary to take to boats, and proceed up the Pit river for two stages, as far as Briansk. Hence one may continue in carriages. Besides these, there are four other roads, named after four of the principal mining companies, and leading to and from their works, viz. Zotof's, from their former residence opposite the village of Pogadaief; Lopatin's, from the former establishment of that firm; Rézanof's, from the village of Ust Pit; and Yermak's, from the well-known centre of the several important companies under this name. These roads are only practicable for equipages during winter; in summer, the journey must be made on horseback; and of the 6 mentioned, none are good, a fact attributable to the rivalry between the different companies, as well as to negligence on the part of contractors. The distance from Yeniseisk to Zotof's works on the Sevaglikon by the new road is 130 miles, or thereabouts, whilst by the old road it is 150 miles. This distance is divided into 6 stages, and a ferry across the Pit. At each of the 6 stations post-horses are kept, and the traveller must provide himself with a road-pass at Yeniseisk. The verstage is 5 *kopecks* (1½*d.*) per horse. The stations are well maintained, and the whole journey from Yeniseisk to the diggings may be accomplished in 36 hours in winter, and 2 to 2½ days in summer. Two roads lead from the northern to the southern system, which will be described hereafter. By the old and new Lifantieva roads the traffic in winter is great, as well as along that known as Yermak's: the supplies for the mining population all pass by one or other of these lines of communication. Those who use the roads pay a tax of 5 *kopecks* (1½*d.*) for each *pud* (36 lb.) transported. This was formerly levied in kind, but has now been commuted into a money payment, and defrays the cost of repairs.

The extent of the northern system, along a line drawn from the estuary of the Pit to the Jochimo, is about 170 miles; and from the mouth of the Chirimba to that of the Jochimo, i. e. from S.E. to N.W., about 135 miles. Here, since mining operations were first commenced to 1864, 517 claims have been allotted; of these, 133 had been worked, and 403,506 lb. of gold obtained, for 43⅓ million tons of detritus washed. At present, 40 to 50 mines are worked, and 8500 to 9000 men employed, besides servants, women, and children. In earlier times, when these gold-fields were at their zenith, i. e. between 1845 and 1860, 12,000 or 15,000 hands were annually employed. Many of the placers are worked out, others are more or less exhausted, and those still at work are less productive than they were. Nowadays, 20 or 30 per cent. profit is considered good, a placer which pays 50 per cent. is unusual, and 100 or

200 per cent. are things of the past. That the decline in prosperity is marked, the following figures will prove :—

Year.	Placers in work.	Hands employed.	Production of gold. lb.	Average yield from 100 *puds* of detritus.
1860	30	10,237	15,309	83
1861	42	9,975	14,325	69
1862	50	11,778	13,574	51½
1863	53	9,269	14,185	66½
1864	55	10,995	12,564	..

The returns for 1865 and 1866 were not accessible when Latkin wrote his report; but it is probable that the number of mines and production remained stationary in both those years, whilst the average number of men employed did not exceed 9000. It is evident, therefore, that although more claims were worked, the number of workmen remained stationary, and the quantity of gold gradually decreased; and were a comparison to be made with earlier years before 1860,* this diminution would be still more apparent. The gold-industry, under altered conditions of supply, is entering a new phase, when to be successfully continued it must be subdivided.

In 1868, the mining companies made large reductions in their establishments, consequent upon the dearness of supplies and the continuation of a high tax on their industry, a modification in which had been in vain expected for 5 years. The number of hands engaged for the northern gold-fields did not exceed 3000 in that year, and about the same number in the southern field. Meanwhile smaller capitalists tided over the crisis, owing to their being more favourably circumstanced as regards taxation. These changes made themselves felt by a falling off in the supply of gold by 6768 lb. less even than 1867.

Gold-washing processes and machinery will be fully described at the end of this section, but it may be worth while mentioning that all improvements in the methods adopted in Siberia were first tried and perfected in the northern Yeniseisk system by large proprietors or managers of mines, e. g. Golubkof, Benardaki, Zotof, and Rézanof, all of whom employed thousands of labourers and extracted many thousands of lb. weight of gold.

The average thickness of the overlying peaty strata does not exceed 8 ft.; but in some localities, it is as much as 16 ft., and in others 43 ft., e. g. on the rivers Ogne, Ogniofka, Yenashimo, and on Danilof spring. In others again, it is only 3 to 5 ft., and even less, e. g. at Magdalene placer, on a spring uniting with the Sevaglikon. The auriferous beds also vary in depth, averaging between 5 and 8 ft.; at Résanof's placer, however, on the Ogne, they are 80 ft. thick. Their width often depends on the size of the stream along which they are situated; thus on the Kalami, Sevaglikon, Vangasha, Ogne, and Yenashimo, they measured 700 to 1400 and even 1700 ft. across.

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* The production of gold in the preceding decade was upwards of 18,000 lb.

The scale of operations at the northern placers is usually much larger than at the southern, and 4- and even 8-barrel machines are not uncommon. Among the latest improvements to be noticed, are the 8-barrel machine at Golubkof's Uspensky mine, with tramway and trucks for bringing the detritus to the machine, worked by an endless rope. The same arrangement is more fully developed at Rézanof's Gavrilof mine, devices which have effected a great economy in manual labour and horse-power. In pumps too, the northern gold-field is a long way ahead of the southern, and in the use of Archimedean screws, and *chetki* or double-action pumps. An enterprising mining proprietor, Lopatin, endeavoured to apply a dredging-machine, similar to those in use at the Suez Canal, to his works, but failed completely after sustaining heavy losses.

Every well-ordered mine is provided with a hospital, apothecary's shop, and medical attendants. The larger establishments have exceedingly good hospitals, and are supplied with medicines from Moscow and St. Petersburg. They have surgical instruments in case of accidents. Their medical staff comprises two doctors and a midwife. Sickness occurs in spring and autumn, and in a cold damp summer. Epidemic diseases hardly ever visit the mining districts. The mortality is usually small—1 to 2 per cent. during the year. The climate, notwithstanding its severity, is on the whole favourable to health, and children thrive remarkably in it. Accidents of a serious nature, from landslips, falling stones, frost-bite, and drowning, though of annual occurrence, are few in number, for the work is generally conducted with due regard to care, and the workpeople are warmly clad. Three churches and six clergy are supported by the mining establishments. The police is under an *ispravnik* or district inspector. Two or three government topographers reside at the mines, and allot and define claims; and a head inspector visits the districts once in the summer, and about which time a staff-officer of gensd'armes appears on the scene. Wages are rather higher in the northern than in the southern districts. The brandy or *vodka* traffic has lately been on the increase, owing to its surreptitious introduction by routes insufficiently guarded. Of course its promoters make large profits by the sale of spirits, and by an illicit traffic with gold, which they receive from the miners, and dispose of to Tartars, Jews, and Russians in the towns, Yeniseisk being notorious for its secret dealers in gold.

Mining operations usually begin early in May, and continue to the 10th (22nd) September, which is the general settling-day. After this, most of the workpeople usually return to their homes, a few only remaining for the winter. These work on to the 1st (13th) March, when they also receive their accounts and either return to their homes, or renew their contracts for the summer.

The treatment of the men was anything but humane a few years ago. They were punished with great severity, and treated more like the brute creation than human beings. Now a wiser spirit has been infused into these dealings, and the mining labourer, though he may be a penal settler, is nevertheless regarded as a man, an improvement doubtless due, in part, to the abolition of corporal punishment. Desertions, formerly very frequent, are now fewer, and the men enjoy better health, owing to the shortening of the hours of labour; their moral character has also improved. But the recollection of the cruelties practised, particularly by one large company, will not soon be effaced.

The northern system was discovered in 1839, though in the previous year gold-seekers had crossed the Great Pit from the southern system. In 1839, the famous deposits on the Aklotik and Vangasha were found, and the next few years saw a rapid development in gold-mining. It was not long before all the streams in the northern system were wholly or partially explored and claimed by parties of miners, who flocked in numbers to the district, as soon as the first brilliant discoveries had been made known. Every one who could afford to fit out a band of prospectors joined in the rush, or took a share in somebody's venture. Of course, a few were disappointed; but by far the greater number succeeded in finding good and profitable alluvions. In this way, the rich firms of Zotof, Golubkof, Soloviev, Malievinsky, Basilefsky, Astashof, Rézanof, Gorokof, Krasilnikof, and others less wealthy and celebrated, were established. But mining enterprise received a check when Government refused to grant certificates to enable private persons to search for gold. Privileges conferred as marks of imperial favour now took their place, and the development of the gold industry was stopped till 1853. In that year private persons were again allowed to prospect and wash for gold. Of the companies receiving Government grants, the most notable were those of Prince Orlof, Princess Madatova, Princess Gortchakof, Princess Troubetskoy, Patkul, Maksimovitch, and a few others. About this period of Government grants much litigation arose in the northern gold-field, many of the suits lasting for years, and causing heavy losses and expenditure. Of the more recent discoveries, that of the Yenashimo and Noiba detritus, by Sidorof, was the most remarkable, for these rivers had been previously prospected and abandoned as unprofitable. Now the Novo-Mariinsky mine of Grigorof and Sidorof, and the small one belonging to Mme. Rodstvennaia, have again restored to the northern Yeniseisk gold-fields some of their pristine glory, and recalled the good old time. The most noted companies, both in the production of gold and in the number of mines worked, were those of Golubkof, Zotof, Astashof, Grigorof, Rézanof, and Benardaki, and these, with the exception of the last, have continued to occupy a leading place; but from 1863, work considerably diminished, and will soon in all probability still further decrease, many continuing to work on a much smaller scale than before.

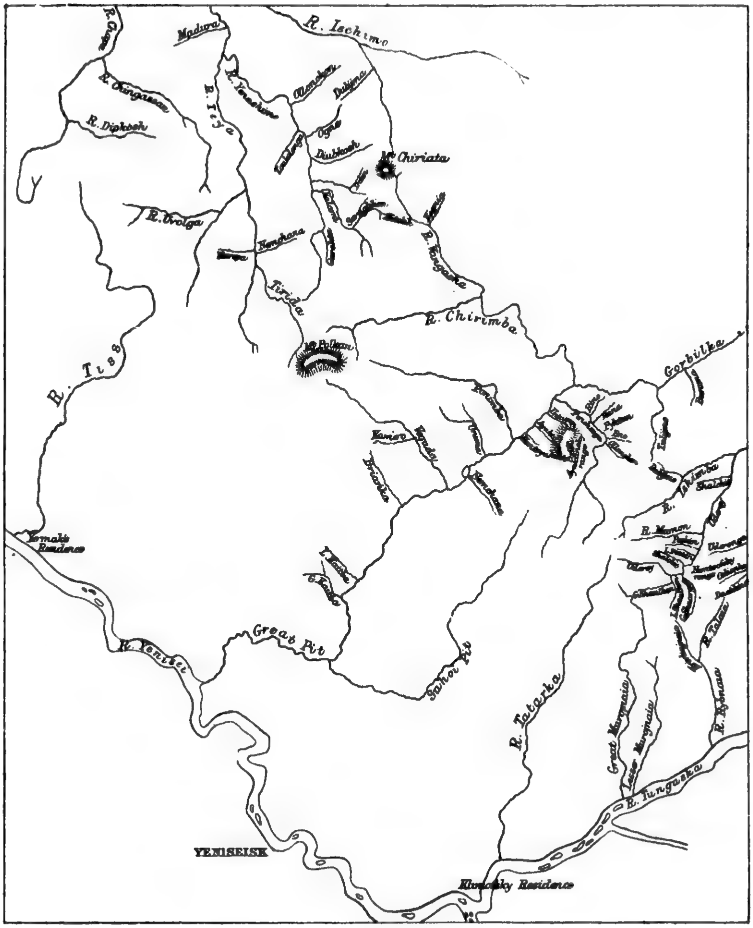
The gold obtained in the northern system is generally fine-grained and flaky, as though it had been subjected to much attrition; in some places, however, e. g. on the Ogne (Upper Yenashimo basin), the gold is coarse-grained and of high standard (90 to 92⅔). Here it is rare to meet with gold covered with a thin crust of oxide of iron, as not unfrequently occurs in the southern system. Upon the whole, the gold in the northern system is not of high quality, except that found in the Ogne, and is mixed with much silver alloy; moreover, it often varies in quality in different parts of the same river, but in general it is worst in the upper part of the river valleys. Thus, at the sources of the Kalami, the gold contains 87⅓ per cent. of pure metal, 8⅓ of silver, and ⅓ alloy; whilst in the central and lower parts of this river-bed, it contains 88½ to 89½ of pure metal, 6½ to 7½ of silver, and ⅓ alloy; the same difference is found on other rivers. The Ogne gold contains 92 to 92⅔ of pure metal, only 3 to ⅔ of silver, and ⅓ alloy.

Yeniseisk Gold-fields. (*b*) *Southern system.*—The southern half of the hilly region of Yenisei is included between 58° 15′ and 60° 20′ N., and between 140° 20′ and 141° 20′ E. It is bounded by the rivers Yenisei, Upper Tungusska [Angyra], and Great Pit, and comprises the auriferous basins of the Uderey, Great Murojnaia, and left affluents of the Pit. On the E. and N.E., the tract under notice has no definite boundaries.

In its geology and leading topographical features, the Southern Yeniseisk region is very similar to the northern. The hills are of no great elevation, the more prominent peaks, like Podgaleshmy, barely exceeding 1800 ft. above sea-level. As no systematic measurements, however, have been taken, there are no positive data for fixing the heights. Here, as in the northern system, are no regular mountain ranges, and the hills mostly follow the valleys of the rivers. Occasionally they are grouped together, and serve as watersheds, for instance, at the sources of the Uderey, Great Murojnaia, Lesser Penchenga, and Tatar.

The rocks are the same metamorphic schists, so often mentioned, inclined at angles varying from 20° to 70°, and now and then rising up in tall naked cliffs. Subsidiary to these schists, and frequently associated with them, are the granites and intruding igneous rocks, such as porphyries and diorites; whilst limestones and sandstones are also conspicuous. Thus, at the sources of the Indigla, a tributary of the Tatar, at the head-waters of this latter stream, on the Lesser and Greater Penchenga, and alongside the Sukhoi (dry) Pit, granites are met with. Again, in that tract included between the Greater Penchenga, Great Pit, the Taktagaika, Untuguna, Ayakta, and Kuntuyakicha, granites and

FIG. 11.



SKETCH-MAP OF YENISEISK GOLD-FIELDS.

mica-schists are the dominant rocks, forming a peculiar loose débris unlike any other in the southern system.

Outcrops of granite too are met with in other localities, e. g. along the banks of the Great Pit and its feeders, as well as in the range dividing the Great Penchenga from the Gorbilka. On the Upper Podgaleshnaia, and the Tala, a tributary of the Great Murojnaia, diorites and fine and coarse-grained greenstones occur allied with metamorphic schists and penetrated by crystals of hiastolite. On the Tala affluent of the Rybnaia (Fish) river, white limestones appear among the clay-schists, standing forth in rugged cliffs. Among the débris of these schists, and on the hills, are strewn quantities of quartz, in blocks and fragments of all sizes, white and yellowish in colour, with a tendency to splinter, and containing mica. Occasionally the quartz lies in thick veins, as at the estuaries of the Taktulaiefka and Lesser Peskino, where they are conspicuous on the sides of the rocks bordering the valley, and in parts of the Great Pit. Besides quartz, the detritus contains, on the Great Murojnaia, an abundance of rounded lumps and cube-shaped crystals of brown iron ore, as well as fragments and whole layers of conglomerate, consisting of pieces of slate, quartz, and brown iron-ore imbedded in ferruginous clay. Much of this conglomerate is found in the lower non-auriferous alluvia overlying the gold-strata, at several placers in the Great Murojnaia Valley, about midway between its sources and mouth, forming a bed 2 to 7 ft. thick, and offering a serious obstacle to mining operations. Similar conglomerate also occurs in other localities along this river, and its tributary the Tala; also at Gromof's placer on the Uderey. Among other minerals in this detritus, are crystals of sulphur-pyrites, copper-pyrites (rare), crystals of stavrolite, at one placer on the Murojnaia nests of copper-ore, even native copper, and at another on Seraphim brook dark-red and yellowish-brown ferruginous ochre. At Spassky placer on the Mamon, and at that of Constantine-Helen on the Great Murojnaia, silver-lead ore was found in nests, but no systematic searches have been hitherto made for these ores. The detritus further contained talc, talcose, micaceous, chloritic, and grauwacke schists. On the Oslianka were gritty sandstones suitable for whetstones, after which this rivulet takes its name.

The experiments conducted by Hoffmann and more recently by Makerofsky in crushing slates are said to have resulted in obtaining gold-dust, but there are doubts if this be really the case. At all events, trials made by Latkin and Bakshévitch produced none. Had these slates contained gold, in the rich proportion too of 3 to 5 *zolotniks*, as said by Hoffmann, mining proprietors would have set up machinery and turned their attention to crushing, since whole hills are composed of nothing but clay-slate. But nobody has ever derived the slightest advantage from

Hoffman's discovery, not even the Rézanofs, at whose placer it was made, and the very idea of such a thing being possible has ceased to exist. In detritus largely composed of granitic and mica-slate fragments, are occasionally found lumps and pieces of felspar, porphyry, diorite, crystals of garnet, almandine, black tourmaline, and rock-crystal. Besides these, magnetic iron-ore enters into the composition more or less of all this detritus, as well as iron-manganese and titanic iron. In the Great Penchenga valley, notably at Rézanof's Ivanofsky placer, the pay-dirt from the washing-boxes contained a quantity of grains of tin-ore ; and on a brook joining the Great Murojnaia, native copper was mixed with gold. The hard subsoil or bed underlying the detritus is mostly composed of metamorphic clay-schists ; but in those localities where granites are the prevailing rocks, close-grained decomposed granite underlies the débris cropping out here and there in reefs of crumbling granite and felspathic quartzose porphyry.

The most remarkable and highest points in the southern system are Mt. Goletz, at the sources of the Upper Podgaleshnaia ; Mt. Pijktun, on the Great Penchenga ; the water-dividing range between the Uderey, Tatarka, Lesser Penchenga, and Great Murojnaia ; also that between the Great Penchenga, Sukhoi (dry) Pit and the streams flowing directly into the Yenisei ; the long hill between the Tala and Lesser Shaargan ; the Osinovy range, between the river Krivliajnaia and the Great Shaargan ; Nemtsofsky ridge, between the Shaulkan and Great Shaargan, so called after a German doctor Lessing who worked a placer at the foot of this hill Mt. Zimoveisky, between the Shalokit and Dulijmo rivers, on the road to the northern system ; and Mt. Ayaktinsky, between the sources of the Ollonokon and Ayakta, or the Ayaktinsky group. All rivers and rivulets of the southern system have the character of mountain torrents, with extremely steep fall (about ½ in. to 7 in. per fathom of 7 ft.) ; their current is therefore very rapid, and during heavy rains they rise quickly, and although, owing to the steepness of their valleys, they do not inundate a wide extent of country, they nevertheless occasion heavy losses, particularly in spring, destroying dams, weirs, bridges, and other mining works. During summer droughts, they become very shallow, and in some places there is not water enough to turn the machinery, causing enormous loss to the mining proprietors, who are obliged to reduce the scale of their operations, owing to the stoppage of their washing-machines. Three of the river basins of the southern system are important, both for the mines situated on them and for the richness of their detritus ; and four others rank as secondary in the gold-industry. The most important river basin is that of the Kamenka [Uderey], (2) the Great Murojnaia, and (3) the Great Pit ; the secondary rivers are : (1) the Tatarka, (2) the Rybnaia, (3) the Lesser Murojnaia, and (4) the Yenisei, including its affluents Dvortsovaia and Zirianka—unimportant streams with poor detritus not worth the washing.

The Uderey, discovered in 1839, is considered to be one of the principal auriferous rivers of the southern system. It flows out of the central group of hills, which gives rise to all the principal rivers in this system: the Great Murojnaia, Lesser Penchenga, and Tatarka. The valley of the Uderey, from its sources to the mouth of the Great Shaargan, has a S.E. direction, except where it forms small elbows near the river Taktulaiefka. Between the Great Shaargan and Shalokit rivers, the Uderey turns sharply to the N.E.; from the estuary of the Shalokit to that of the Uromka, it resumes its S.E. direction, and lower down falls into the Kamenka, a tributary of the Angara. The Uderey is 70 miles long. At first of insignificant breadth, it afterwards increases to about 100 ft. near the Mamon, and below this to 140 ft. and upwards. Its valley is open throughout, except immediately above the mouth of the Taktulaiefka, where it is much contracted by hills; nowhere, however, does it exceed ⅔ mile in width. The land is swampy, and mostly covered with bushes and dwarf trees; some good grass-land, however, is to be found along it. The Uderey rises by three sources, one of which was formerly celebrated for its rich and widely disseminated gold-alluvia. This was the site of the well-known Uspensky mine of the Rézanofs, which produced between 1841 and 1864, 14,814 lb. of gold. It is now nearly exhausted, and the affairs of its proprietors are in confusion, notwithstanding the 4,500,000 *rubles'* (562,500*l.*) worth of gold they have raised.

Another placer, the Voskresensky, owned by Benardaki, Rézanof, and Schogolef, was also famed for its wealth, having yielded up to 1864, 4572 lb. of the precious metal. The detritus here was 700 to 1000 ft. wide, whilst the overlying strata did not exceed 8 ft. in thickness, and in places even less, so that on removing the *tundra* moss, the auriferous deposits were almost immediately disclosed; their depth averaged between 8 and 14 ft. These deposits were mostly composed of clay, containing fragments and boulders of clay-schist and quartz; the lowermost series, however, containing but little clay, were probably formed of the underlying schistose rocks, disposed in the usual slanting position, with cubic crystals of brown ironstone. The northernmost parts of this valley were especially remarkable for the compact character of the stratum, which had therefore to be washed in bowls. The scarcity of water consequent on the drainage of the marsh-land at the sources of this river, necessitated the introduction of steam power. The other placers on this rivulet yielded in all 585 lb. On the central of the three head streams of the Uderey, was situated the Mitrofanof placer of Benardaki, Schogolef, and Rézanof, whence 4176 lb. were raised; whilst on the left, was the Innokenty of the Miasnikofs, famed for its nuggets and variable detritus, which yielded 3366 lb. to 1864, and is now abandoned. At the confluence of these two streams, and lower down, lay the once rich though small Nikolaief placer of the Astashofs, which produced from 1851 to 1860, 4122 lb. of gold, and is also not worked at present. Below the point where the head-waters of the Uderey unite, the detritus alters a good deal, becoming a narrow belt not exceeding 170 ft. in width, with a poor yield of gold, and this continues to the Gromof mine of the Popofs, below which it does not repay the cost of washing. The other placers on the Upper Uderey yielded in all 1872 lb. of gold to 1864; but as no thorough explorations have been made here, it is impossible to say what their real value may be. Below the Taktulaiefka, the Uderey is joined by another stream, the Taktagaika, on the left. Here were situated two placers, with only a moderate quantity of gold, sufficient, however, to be profitably worked; from one of them, 2268 lb. had been raised up to 1864; and from the other, 306 lb. between 1862–64. Below the Taktagaika, several smaller rivulets fall into the Uderey on the left. On the right bank, however, this river is joined by the Shaulkan, with a course of 10 miles, and rich detritus between 3 and 8 ft. thick. The alluvium, which has been successfully worked at several placers, is clay, grey, pale-yellow, dark-brown, and greenish in colour, containing quantities of shingle and fragments of slate and quartz, beneath peat 5 to 12 ft. thick. Here was a rich digging of the Astashofs, the Stepanof, which yielded between 1844 and 1864, 4680 lb.

This was the residence of the Government mining inspector of the southern system, and here were the houses of the medical staff, so that the Stepanof placer was considered as the capital or centre of the southern Yeniseisk gold-field. Metamorphic clay-slates are again the dominant rocks. In the Shaulkan valley, moreover, traces were discovered of lateral moraines in the long parallel rows of schistose boulders disposed along it. Another highly auriferous affluent of the Uderey is the Great Shaargan, flowing from the range which parts the feeders of the Angara from those of the Uderey. About two-thirds of the way down its course, it receives the Lesser Shaargan, discovered in 1838 by the Rézanofs, and noted for its rich detritus. The Great Shaargan is about 13 miles, the Lesser 7 miles long. On the former, the most remunerative placers were those owned by Dondukof-Korsakof, Patkul, and Schogolef; the others were less productive. The yield of all these placers, 8 in number, however, was only 4536 lb. up to 1864, and at present they are mostly closed. On the Lesser Shaargan, is the noted Petropavlof placer of the Rézanofs. This annually gave 1440 lb. of gold between 1840 and 1850, but it has now dwindled to almost insignificance, after having produced

19,692 lb. from 1839 to 1864. The next in importance was the Blagodatny of the Bunakof Company, afterwards Rézanof's, from which 3141 lb. were raised up to 1864. The total obtained from all the placers on both Shaargans was 33,624 lb. from 4,600,000 tons of alluvium washed.

Still lower, the Uderey receives the Shalokit, upon which were two placers; one of these contributed 1908 lb. in the 7 years 1857–64; the other, 909 lb. between 1861 and 1864. The diggings on the Uromka, another insignificant right affluent of the Uderey, produced 117 lb. up to 1864. It is only from the mouth of the Great Shaargan that the Uderey begins to be auriferous; thus, at the Borissoglebsk claim of the Co. Popof, and at the Alexandrof of Yakovlef and Astashof, a good quantity of gold has been found, but these placers have not yet been worked. On the left, the Lesser and Greater Peskino fall into the Uderey. On the Greater Peskino, only 6½ miles long, was the famous Spassky mine, belonging to Miasnikof's Company, from which were raised between 1840 and 1864, 26,928 lb. of gold. This was nearly worked out, and operations were continued only on a small scale. The other 6 placers on this rivulet yielded altogether 9720 lb., making a total of 36,648 lb. from the Great Peskino. The lesser rivulet of this name produced 1044 lb.; and the detritus washed on both streams amounted to 3 million tons. Below the two Peskino rivulets, several small streams join the Uderey; but with the exception of two, the Mamon and Ishimba, gold is thinly distributed through them. The valley of the Mamon has a length of about 15 miles, with a general direction from N.W. to E.; its detritus yielded a fair quantity of gold, especially at the Blagoveschensk placer of Jakobsen and Benardaki, and the Sergiefsky of the Princess Gortchakof. The Mamon alluvial deposits were discovered in 1839, and were first worked in 1845. The stratum is friable, and forms a belt 280 to 500 ft. wide, with a thickness of 6 to 7 ft. The prevailing formations here and in the surrounding mountains were metamorphic clay-schists. Among the more remarkable discoveries, mention should not be omitted here of a nest of silver-lead ore at the Spassky placer of Krasilnikof and Popof. The gold raised on the Mamon from the commencement of operations to 1864 amounted to 11,880 lb. The former rich placers are now exhausted, but work has been resumed at 5 claims, employing 700 men.

The Ishimba rises in the same group of hills as the Mamon, and receives a number of auriferous brooks, at which washings are still continued, though on a small scale, and with slender hopes of any marked improvement in the future. They can only be developed by cheap labour, for the yield is poor—scarcely over 30 *doilias* (20½ gr.) per 3600 lb. The other tributaries of the Uderey are either unexplored or deficient in gold, and though it is impossible to see far into the future, it is nevertheless probable that the detritus in the valley of the Uderey will never be worth working, except at the estuaries of the rivulets, e. g. the Peskino streams, the Uromka, Great Shaargan, and Taktagaika. The valleys of the Uderey and its affluents produced up to 1864, 140,000 lb. of gold from 17,800,000 tons of alluvium, washed in all kinds of apparatus, from hand-bowls and buddles to the barrels now in such general use.

The Great Murojnaia flows in the southern Yeniseisk gold-field from a group of hills which serve to divide all the principal streams, such as the Tatarka, Penchenga, and Uderey. The valley of the Murojnaia is about 70 miles long; its general direction is at first N.W. to S.E., then N.E. to S.W., and afterwards S. Its right affluents, taking them in their order, are Talaia, Upper Podgaleshnaia, Chumbukli, Bezimiannaia [nameless], and Chikil; its left, the Borovaia, Bezimiannaia [nameless], a left source, and the Tiurepina. From a width of 7 ft. near its source, it increases to 140 ft. in the lower reaches. Its valley, 2800 ft. wide in places, contracts lower down, and the river flows between precipitous walls, leaving but a narrow strip of bank on either side. On the upper course, the detritus is very compact, but from the mouth of the Talaia it is more friable; in width, it varies from 350 to 700 ft., with a depth of 5 to 10 ft.

On the Talaia, however, the auriferous stratum is 140 ft. thick, though poor in gold, about 50 to 60 *doilias* (34 to 54½ gr.), with an occasional richer seam. The richest placers on the Murojnaia were situated on its head-waters. These were celebrated for the large number of nuggets found there, some of which weighed over 10 lb. At two of these claims, worked by the Schogolefs, 23,868 lb. were raised between 1841 and 1864; and at two others, during the same period, 28,512 lb. It should be mentioned that the style of work was in former times so bad, that the waste sands, peat, and gravel have been found to contain on re-washing a fair proportion of gold. But these placers are not nearly so productive as they were. Another, the Iliinsky claim of the Shushlaiefs, was no less remarkable for the deep overlying peaty strata, 55 ft. thick in places, than for the rich but uncertain detritus found below it, 5 to 10 and 16 ft. thick. Here, between 1850 and 1863, 7524 lb. of gold were washed. At another placer, situated in a narrow valley at the foot of the Podgaleshnaia hills, which contain Mt. Goletz, the highest peak of the southern system, a bed of copper-ore was discovered; whilst at a third, the Spassky, on the Borovaia rivulet, a tributary of the Murojnaia, shafts were sunk, but in such an irregular fashion that the placer has suffered from this mode of work. The detritus here was particularly clayey compact, and so difficult to wash that it had to be crushed in bowls, the usual method of treating alluvium of this kind. The Spassky placer yielded between 1844 and 1854, 3240 lb. of gold. The other diggings on the Murojnaia and its affluents produced 9180 lb. between 1844 and 1864, 28 claims having been worked during the whole of that period. Their number is now reduced to 8, employing 1500 men, who raise annually 1800 lb. of gold. The total quantity obtained on the Murojnaia and its affluents was 74,124 lb. from about 10 million tons of alluvium washed.

The auriferous deposits on the head-waters of the Great Murojnaia and the Borovaia consist of a rich clay, yellowish and red in colour, with little of the schistose débris, but an abundance of boulders of quartz, some exceeding 30 cwt. in weight, of a white and bluish-white colour, the yellow being apparently distinct. The most remarkable of these quartz deposits were found on a spring joining the Borovaia, and near the union of the head-waters of the Great Murojnaia. Lower down, from the mouth of the Borovaia to that of the Talaia, the alluvia are yellowish-grey clay, with fragments of talc-schist, diorite, and quartz. Below the Talaia is less clay, the upper strata consisting of fluviatile deposits and shingle, with schistose fragments, brown iron-ore and quartz, together with occasional fragments and pebbles of talcose and chloritic slates and diorites. The lower layers are composed of disintegrating clay-schists, inclined at a steep angle, and crossing the valley from N.W. to S.E. The subsoil or bed is of similar schists, less decomposed, however, and devoid of gold. Calcspar was reported to have been met with at one locality.

The Great Pit is the administrative boundary between the northern and southern systems. It rises in all probability in the hills which divide the affluents of the Central or Podkamennaia Tungusska. Its general direction is S.W., but from the mouth of the Kaitba, it turns S., from that of the Sukhoi [dry] Pit N.E., and from the estuary of the Kamenka has again a S.W. course to its confluence with the Yenisei, near the village of Ust Pit. Its length has been estimated at 230 miles, and its width, from the confluence of its head-waters to the Chirimba, at not over 100 to 140 ft.; below this point, however, it increases to 280 ft. and in places to 560 ft., whilst below its junction with the Brianka it measures upwards of 700 ft. across, and is navigable all the summer for laden boats. The Pit is in fact the means of transporting supplies to the Ust Briansk wharf, and in some years 36,000 cwt. pass this way. Boats with a light draught of water, yet capable of carrying 5 to 8 tons, can ply as high up as the mouth of the Kadra, where Latkin's warehouses are situated. Below the Brianka, the Pit is only fordable after a very dry season; above, are practicable fords in dry weather. But the Pit is liable to sudden freshets, and its current is so extremely rapid at flood time that it is difficult to cross even by the ferries. The valley of the Pit is very beautiful, and as much as $\frac{2}{3}$ mile wide; parts of it, however, are not over 700 ft., and others not over 350 ft., where the river flows through a gorge, as it does near the Ayakta and Tavrikul, with a velocity of 10 miles per hour, forming rapids, and contracting its channel to no more than 140 ft.

There are some good grass-lands along the Pit, which Government rents to private individuals or to the gold-miners. The banks are hilly, and occasionally wild and picturesque. The formations are, so far as external appearances indicate, the same metamorphic and especially clay-schists; but no geologist has surveyed this valley, and its upper parts are hardly known, few persons having been there. The right affluents of the Pit have been mentioned in the description of the northern system (see pp. 378–97); on the left, it receives the Gorbilka, with a course of about 70 miles, fed by two auriferous brooks, the Buruma and Tujimo. On these, washing operations were at one time carried on, but are now discontinued, the detritus being too poor. Seven miles below the Gorbilka, the Pit is joined by the Penchenga, a fine stream flowing from the central group of hills, in which all the principal rivers of the southern system take their rise. After uniting its head-waters, the Penchenga takes a N.E. course, but on meeting with the Morkol, it turns N.W., and flows in this direction as far as its confluence with the Ollonokon. Here the Penchenga again flows N.E. to the mouth of the Eno, whence it continues in a N.W. direction to the Great Pit. The Penchenga is about 50 miles long, and its valley is 1000 to upwards of 2000 ft. broad, with scenery of remarkable beauty. Here and there an expanse of grass-land gives the gold-miners the opportunity of laying in a stock of hay. The river itself is about 35 ft. wide in its central parts, but, after receiving its tributary, the Lesser Penchenga, increases to 100, and lower down to 200 ft. Its depth is 2 to 3 ft. and upwards, though it is everywhere fordable except during floods. Small light boats navigate the Penchenga all summer through, and in May large craft might pass up. A number of auriferous streams fall into the Penchenga: those on the right are the Bezimianka, Ivanofka, and Lesser Penchenga, with the Lesser Morkol, Chilcha, Eno, Kiuna, and Rino; on the left, are the Beltagan, Tompo, three Ollonokons, and the good-sized Kognia.

The Greater lower Ollonokon rises in the Ayakta group, and flows at first S.W., then S.S.W., for 7 miles, with a channel not exceeding 7 ft. in width. Its valley is 140 to 700 ft. wide. The detritus and surrounding hills are chiefly composed of metamorphic schists. The auriferous deposits form a belt 8 to 12 ft. thick, and 56 to 175 ft. wide, and are of a compact kind. The Ollonokon was discovered in 1840 by the Demidofs, and at first worked by them; but in 1859 the place passed into the hands of Latkin. Up to 1865, 3636 lb. of gold had been raised here 600,000 tons of alluvium having been washed. In some fragments of talc- and mica-schists composing this detritus, crystals of stavrolite had been found, not only here but elsewhere. The valleys of the Great

Penchenga have not yet been worked for gold, the yield being considered too poor; but on lateral brooks, washing operations were at one time carried on. Metamorphic schists are the prevailing formations, but at the sources of this river, and near the mouth of the Kognia, coarse granites, grey and reddish in colour, have intruded through the slates. The detritus on the lateral brooks is loose, and lies in a belt 100 to 200 ft. wide and 4 to 8 ft. thick. Claims have been worked, but not continuously, in these localities; up to 1864, 2952 lb. of gold were obtained, and it may be possible under favourable conditions to proceed with the work on a small scale. The Lesser Penchenga, a tributary of the aforesaid river, is 27 miles long, and remarkably picturesque; but it is not famous for its gold, though at two localities the detritus has been worked.

Below the confluence of the Great Penchenga with the Pit, the American system of washing has been successfully practised at Latkin's claim on the Untuguna rivulet.

The Ayakta, another small rivulet 7 miles long, rising in the Ayaktinsky hills lying between the right bank of the Penchenga and the left of the Pit, has been worked since 1855 by Latkin. Here the detritus is so loose as to be easily washed in American sluice-boxes. This is in fact the only place in the whole Yeniseisk circuit where work is conducted on a large scale without any other apparatus than the American. On the Ayakta, 1440 lb. of gold were obtained between 1855 and 1864. From the group of hills which gives rise to the Ayakta, 7 rivulets flow in different directions, viz. the Ayakta, its left tributary the Kuntuyakicha, the Untuguna, Taktagaika, two Ollonokons, and the Lower Sevaglikon. In the case of the last 3, the detritus is schistose; in that of the first 4, granitic. The Ayakta alluvia contain almandines, rubies (but not of fine water), tourmalines, and an abundance of zircon; 300,000 tons of ore-stuff have been washed in the Ayakta valley. All the other feeders of the Great Pit are very deficient in gold, and are not worth working. Along its banks, however, for some distance passes a high road, which connects the town of Yeniseisk with the diggings. In some parts, it is only practicable for horsemen, whilst in others, wheeled equipages may drive along it. It is this road and the fine grass-lands which lie in its valley that lend importance to the Great Pit, rather than its gold, which is too sparsely disseminated to be of value.

Besides the tributaries of the Pit already mentioned, gold was obtained in the following localities and quantities up to 1865:—On the Untuguna, 252 lb.; on the Tavrikul, 360 lb.; on the Kadra, 54 lb.; on the Kamero, 198 lb.; on the Ponimba, 216 lb.; on the tributaries of the Gorbilka: the Buruma and Tujimo, 144 lb.; altogether, 1224 lb. Along the Lesser Murojnaia, no washings have taken place, though gold is known to exist, in such small quantities, however, as not to be worth the

.abour of obtaining. This river is 45 miles long, and flows into the Angara. The Rybnaia (fish river), an affluent of the Angara, rises in a small group of hills, which contains the sources of the Lesser Shaargan, Great Talaia, Udorvuga, and its tributaries the Oslianka and Dashkina. Along the 3 last-named, auriferous deposits have been discovered. The Rybnaia flows S.S.W., then S.W., afterwards S.E., and finally, before joining the Angara, S.W. At its estuary, stands the village of Motigin, on the high right bank of the Angara, which owes its importance to the newly-erected warehouses for storing grain floated down the Angara from the government of Irkutsk. Motigin has four shops of a permanent character for the retail of all kinds of commodities, and a dozen wholesale and retail spirit stores, though the place does not contain more than 25 houses. When the season is over at the diggings, and the workmen are returning to their homes, the drinking taverns are nearly doubled in number, and ten or a dozen calico-print shops spring into existence. The transport of grain, however, has fallen off, compared to what it used to be in former years, when 40 laden barks on an average, with 3200 tons of merchandize, annually passed this way. The Rybnaia is joined on the right by the auriferous Great Talaia, fed by the Lesser Talaia, lower down by the Krivliajnaia with a poor detritus, and by the Mostovaia; its left affluents are of no importance. The placers on the Talaia rivulets were discovered in 1838 by the Rézanofs, and yielded to 1864, 1332 lb. of gold from 330,000 tons of sand washed. The workings here had been almost closed, but in 1867–68 were reopened by Dr. Viliamofsky, lessee of Rézanof. The other placers on the Rybnaia and its tributaries may be passed over. The only road to the southern diggings practicable throughout the summer for carriages lay up the Rybnaia, and was kept in repair by the mining community. There are two stations on it, and a winter track also passes this way to the sources of the Shaargan. The Rybnaia is 35 to 100 ft. wide, and is crossed by 4 bridges. Besides the usual clay-slates, limestone cliffs make their appearance on the Great Talaia; but these contain no fossils, have no regular stratification, and the rock does not combine with acids. Limestone débris containing sulphur-pyrites, lumps and boulders of white and yellow micaceous quartz, and fragments of hard clay-slate make up the detritus in the Great Talaia valley.

The Tatarka (70 miles), a tributary of the Angara, rises by two sources in the same range of hills as do the Uderey and two Penchengas. It receives on the left the following auriferous rivulets: Bezimiannaia, Indigla, Podgaleshnaia, and Mostovaia, with its tributary the Lujka; on the right, it is joined by several unimportant brooks. The detritus on the Tatarka, though discovered in 1839, was only fully explored in 1854. It is friable, mostly granitic, and contains only a small quantity of gold.

Two placers located by the Astashofs were worked here from 1856 to 1864, and produced in that period 698 lb., the proportion being 44 *doilias* (30 gr.) per 3600 lb.

There are no navigable rivers, strictly speaking, in the southern system, with the exception of those flowing round its borders: the Angara, Yenisei, and Great Pit; but several, such as the Uderey, Greater and Lesser Murojnaia, Tatarka, and Great Penchenga, are navigable in light boats as far as about half-way up their streams. The water is clear and good, except where gold-washing operations are carried on. The climate is severe, though rather less so than in the northern system, and the same influences are beginning to affect it.

A *résumé* of the southern system shows it to be 120 miles from north to south. From its first discovery to 1864, 542 claims have been allotted; of these, 123 have been constantly worked; 224,784 lb. of gold were obtained, and 31½ million tons of ore-stuff washed, equal to 1,576,141 cub. fathoms, exclusive of those diggings only located for a couple of summers, which are not worth mentioning.

Taking the production of the southern system by rivers, it may be estimated as follows:—

	Sands washed.	Gold raised.	Average yield per 3600 lb.
	tons.	lb.	doil. zol. doil.
Basin of the Great Pit	2,000,000	9,611	67 to 1 13
Do. Great Murojnaia	10,000,000	74,124	1 28
Do. Tatarka	250,000	699	0 44
Do. Rybnaia	350,000	1342	0 61
Do. Uderey	18,000,000	138,960	from 89 to 2 11

On p. 442 are given later statistics of these gold-fields, which have occupied so important a place in the gold-industry of Siberia, and continue down to the present day to contribute largely to its production.

The following table gives the production of the Yeniseisk circuit from 1834 to 1874:—

	Alluvium, washed.	Average yield.	Gold obtained.	Average per year.	Average number of men engaged.
	million tons.	zol. doil.	lb.	lb.	
1834–8	0·1	3 0	1,778	..	..
1839–40	0·08	2 90½	1,367	684	..
1841–45	4·0	4 9¾	94,384	18,877	11·983
1846–50	12·4	2 48⅛	192,512	38,502	17·734
1851–55	22·2	1 9⅛	143,680	28,736	20·069
1856–60	25·6	0 93½	146,642	29,330	21·625
1861–65	30·0	0 56⅞	100,400	20,080	16·051
1866–70	20·3	0 54⅓	70,241	14,049	15·190
1871–73	11·8	0 60⅝	43,414	14,470	13·118
1874	3·6	0 55½	12,212	12,212	..
	130·08	1 6	806,630		

It appears from this that the richest detritus was worked in 1846–50; from 1846, the annual production rose to nearly 20,000 lb.; from 1861, there was a falling off both in the quantity of gold raised and percentage of metal. The industry assumed smaller proportions, and it was expected that gold-washings on a smaller scale would take the place of the great operations of former times, unless vein-mining were to restore the enterprise to something like its past glory, and develop the vast stores of wealth believed to be still hidden in the Yeniseisk circuit.

On the Angara, and streams flowing into Lake Baikal, gold-washing has been pursued with breaks since 1839; but in 1867, owing to the poorness of the detritus, it was discontinued. The total quantity of sand washed amounted to 300,000 tons, with an average yield of 33½*d.* per 3600 lb., and 586 lb. of gold were obtained.

Atchinsk and Minusinsk.—The foregoing detailed account of the Yenisei gold-fields, divided into northern and southern systems, by no means comprises the whole area in the government of Yeniseisk in which gold is known to exist. To the south, lie the circuits of Atchinsk and Minusinsk, which though comparatively small, cover a vast extent of territory, and have for many years contributed to the gold-production of Siberia. The placers here are situated on the head-waters of the Yenisei, between spurs of the Sayan range, along the rivers Black and White Yuss, Sisima, Algiaka, Amila, Saiba, Kezir, and Bliamika. The Atchinsk deposits, though poorer in gold, are more extensive and have been less worked than those of Minusinsk. They were first discovered on the Black Yuss in 1832, and in the following year on the White Yuss, the richest of all being on the Serali Yuss. The total production up to 1859 in Atchinsk, was 12,018 lb.; for later statistics, reference has been made to Bogoliubsky's work.

Minusinsk includes the southernmost parts of the government of Yeniseisk, where the Sayan range, throwing up heights between 6000 and 7000 ft., divides it from Chinese Mongolia, a tract of wild plains or steppes intersected by low ridges of naked hills and dotted with lakes. The great river Yenisei, after cutting its channel through the mountains, debouches in the plains, and flows due north, dividing the circuit of Minusinsk into two unequal parts. Of the rocks, crystalline formations, such as granites, protogene, syenite, diabase, diorite, porphyry, and metaphyre, are conspicuous, not only in the more elevated tracts, but also in the lower spurs, cropping out along the banks of the Yenisei, wherever this river has eroded its banks. Not less frequent are the talc-schists of the Sayan range, and the more widely distributed sedimentary rocks: schists, limestones, sandstones, and conglomerates, all Palæozoic (of the Devonian and Carboniferous periods). Gold is found on the Upper Amila and northern slope of the Sayan range; it is collected by

Russians on the Chinese side in the district of the river Sistikema, along the rivulets Chorny (Black) and Agiana; on the Jjinjur, Kundusuk, Tinkhet, Kyna, Bez, and Kopa; on the Kezir, and its right affluents the Shinda, Chibejeka and Jebb; on the Sisima, and two Saiba rivulets; on the eastern flanks of the Alatau, the left affluents of Abakan, and the right tributaries of the White Yuss. Moreover Minusinsk is of importance to the gold-industry, owing to its highly fertile soil; the corn grown here supplies its own mining districts, and the more distant gold-fields on the Yenisei, whither it is sent in barks. There were 58 placers in actual work in Minusinsk in 1862, but only 32 in the following year. During the 15 years 1845–59, 25,713 lb. were raised, an average of 1616 lb. per annum. The following is based on Bogoliubsky's calculations of the production of gold in Atchinsk and Minusinsk:—

	Alluvium washed.	Gold raised.	Average per ann.	Men employed.	Quantity washed per man.
	million tons.	lb.			cub. faths.
1834–55	10·0	32,724	1488	..	..
1856–60	7·0	16,143	3230	19,069	22·87
1861–65	5·0	11,948	2389	13,158	24·40
1866–70	4·9	9,071	1814	9,763	30·24
1871–73	2·8	5,213	1737	6,385	27·25
1874	0·73	1,791	1791	..	..
	30·43	76,890	1876		

The average yield for the whole period was 41 *doilias* (27·88 gr.) per 3600 lb. of soil washed,—an infinitesimal quantity.

Kansk and Nijneudinsk.—Next to the Atchinsk and Minusinsk gold-fields, those of Kansk, in the government of Yeniseisk, and of Nijneudinsk, in the government of Irkutsk, have to be considered. The Kansk *okrug* or circuit occupies the S.E. corner of the Yeniseisk government, and is bordered on the S. by the same Sayan range already mentioned, spurs of the Sayan filling a large part of it. The longest of these, the Biriussa, enters Nijneudinsk between the head-waters of the Ud and Biriussa, with an absolute elevation of 6500 ft., and stretches away to the N.E. for a great distance. Another ramification of the Sayan chain divides the waters of the Biriussa and Usolka from those of the Kan. This river, navigable in its lower course, waters the southern and western parts of the circuit, and flows from the town of Kansk to its estuary in the Yenisei through highly fertile tracts. The N.W. border of Kansk is formed for 80 miles by the Yenisei, and the Tasaieva [Lower Ud] intersects it on the north, receiving as its chief tributary the Biriussa, which flows for 470 miles through the district. The geology has been but little studied. In its southernmost parts, crystalline rocks, viz. granites, syenites, and porphyries, prevail. These have uplifted the clay-schists of the Sayan and Biriussa hills. In the valleys of the Kan and Biriussa, greenstone protrudes through metamorphic limestones and talc-schists, and in northern parts of the circuit, sandstones and Carboniferous rocks underlie limestones of the Triassic formation. The gold is mostly found in clay-schists on the head-waters of the Kan and Agul; in the Nijneudinsk circuit, it is distributed on the Biriussa, and its affluents, the lesser Biriussa, Horma and others.

The following table will show the production of the Kansk and Nijneudinsk circuits to 1874:—

	Alluvium washed.	Average yield of gold.		Quantity of gold raised.	Average for the year.
	million tons.	zol.	gr.	lb.	
1838–40	0·27	3	5¼	4,926	1642
1841–45	1·7	2	25⅜	22,405	4481
1846–50	1·4	1	4⅝	8,785	1760
1851–55	1·5	0	71	6,592	1318
1856–60	1·8	0	63⅞	7,034	1407
1861–65	2·0	0	44	5,545	1109
1866–70	1·64	0	41¾	4,198	840
1871–73	0·42	0	65¼	1,702	540
1874	0·17	0	57	609	609
	10·9	0	92¾	61,796	

This shows an increase in the quantity of the work done up to 1865, due to a more systematic method of work, and a diminution from 1871, both in the work done and the gold obtained; whilst the percentage of gold to alluvium had dwindled in 1874 to about one-sixth of what it had been in 1838–40.

Verkneudinsk.—The gold-field of Verkneudinsk, in the government of Irkutsk, S.E. of lake Baikal, lies on the Chita, a tributary of the Selenga, which falls into lake Baikal; and in the valleys of the S.W. slopes of the Yablounovoi range, near Mongolia; but the detritus is not remarkably rich. Gold-washing began in Verkhneudinsk in 1849. The total produced to 1874 was 17,640 lb., with a yearly average of 678 lb. In 1877, the production was 480 lb. To the northward lie highly auriferous tracts, in the basin of the Lena. The first in order, proceeding from south to north, is in the Verkho-Lensk circuit, on the upper waters of the Lena, a region abounding with every necessary of life, dense forests and ample supply of water; moreover, it is near inhabited districts. The detritus here has only been worked since 1867 at one placer, which has yielded up to 1874, 326½ lb. of gold from 100,000 tons of alluvium washed. The quantity raised in 1877 had fallen to 4 lb., but the work had not been pursued continuously.

Barguzinsk.—The Barguzinsk circuit in Trans-Baikalia contains the head-waters of many auriferous streams flowing into the Vitim, a right tributary of the Lena. These deposits are as yet imperfectly known; probably much more gold will be discovered. The following shows the results of washings in Barguzinsk:—

	Alluvium washed.	Average yield per 3600 lb.	Gold raised.	Average for the year.	Number of men employed.
	million tons.	zol. doil.	lb.	lb.	
1854–5	0·09	0 41	246	123	200
1856–60	0·7	1 24	5,181	1036	556
1861–65	2·2	1 47	19,142	3828	2297
1866–70	2·0	1 26	15,239	3048	1826
1871–73	1·09	0 94⅞	6,372	2124	1386
1874	0·23	1 2⅞	1,416	1416	..
	6·31	1 25¼	47,596		

In 1877, the quantity of gold raised in the Barguzinsk circuit amounted to 983 lb.

Olekminsk.—The placers in the Olekminsk circuit of the Yakutsk *oblast* are situated in the basins of the Vitim and Olekma (both of them right tributaries of the Lena), a tract characterized by extremes of climate, and a soil which does not admit of cultivation and which is therefore incapable of supporting man. Its mineral resources, however, make up for its natural disadvantages, and have transformed what otherwise would have remained a barren and inhospitable region into the busiest centre of the gold-mining industry of Siberia. Here the operations of gold-washing are conducted on a large scale, and require a proportionate outlay of capital. Enterprising mining owners run steamers down the Lena and its main affluents for the transport of supplies, labourers, and merchandise of all kinds for the diggings. Owing to the frozen state of the ground, which remains unthawed all the year round, and the depth of the detritus, much of it being 70 ft. below the surface, the work is mostly underground.

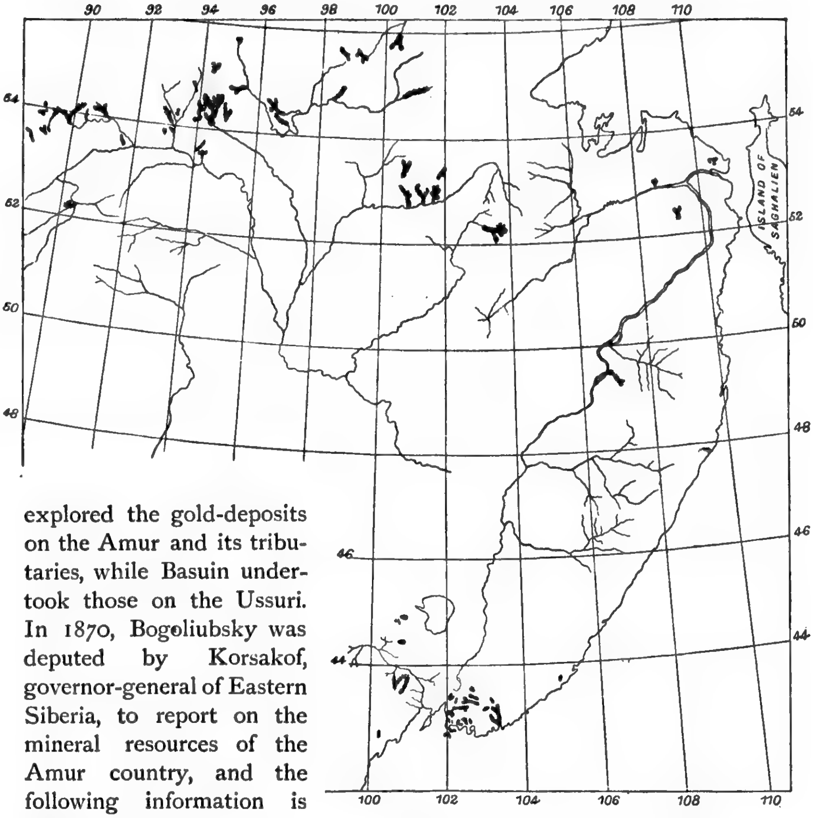
The following figures show the results of the Olekminsk gold-field from 1849, the year when they were opened:—

	Alluvium washed.	Average yield per 3600 lb.	Gold raised.	Average annual production.	Average annual number of men.
	million tons.	doil.	lb.	lb.	
1849–50	0·0015	0 64⅞	7	3⅛	..
1851–55	0·53	2 31½	7,299	1,469	4509
1856–60	4·2	1 24¼	31,350	6,270	4255
1861–65	5·23	1 46⅜	36,518	7,303	4278
1866–70	6·8	1 86⅜	75,849	15,170	5447
1871–73	4·0	2 93¼	71,484	23,828	6558
1874	1·03	3 64⅛	22,252	22,252	..
	21·7	1 86⅜	244,759		

It is expected that ere long the Lena gold-fields will produce annually 36,000 lb.; indeed the production for 1877 was not far short of this, 34,397 lb. having been raised from the placers in the Lena basin in that year, or considerably over ⅓ of the whole supply of the year, estimated at 90,078 lb.

The Gold-fields on the Amur.—Between 1857 and 1860, Anosof explored the gold-deposits on the Amur and its tributaries, while Basuin undertook those on the Ussuri. In 1870, Bogoliubsky was deputed by Korsakof, governor-general of Eastern Siberia, to report on the mineral resources of the Amur country, and the following information is mainly derived from his published works.

FIG. 12.



SKETCH-MAP OF AMUR GOLD-FIELDS.

The Amur, both in Russian and Chinese territory, is auriferous. Its head-waters, the Shilka and Argun, within the circuit of Nerchinsk, contain large quantities of gold, as do also its left tributaries, which have their sources in the Stanovoi range, forming a continuation of the

Yablonnoi. It was the chief object of the Trans-Baikalian expedition of 1849, ostensibly sent to define the boundary with China, to discover the placers in the Amur country. Two mining engineers, Nieglitsky and Koranko, with some Nerchinsk workmen, accompanied the expedition. On entering the slopes of Amazar, gold was discovered on the river Tiksan [upper Amazar], and traces of it on the northern side of the range in the Yakutsk circuit, on tributaries of the Utam, an affluent of the Gonama; descending the basin of the Zéhya, gold was found on its tributary the Kapuri at the depth of 7 ft. from the surface, but in extremely small quantities,—20 *doilias* (13½ gr.) per 100 *puds* (3600 lb.). Another detachment of this expedition under Koranko, while following a spur of highland running parallel with the Ud, came upon gold on the river Ugakan, an affluent of the Shevli falling into the Ud. Traces of the precious metal were further discovered in the rivers discharging into the Sea of Okhotsk, between the mouths of the Ud and Tugur; and upon the annexation of the Amur country under the auspices of Count Muravieff-Amursky, all the chief affluents of the Amur were examined by parties of explorers, under the direction of mining engineer Anosof in 1858–60. Gold was also reported to exist in Chinese territory, on tributaries of the Argun, Sungari, and Suifun. In 1866, private individuals were allowed to search for it in the Amursky and Primorsky (maritime) districts. Following is a résumé of the localities in which gold has been discovered either by Government or by private persons in the basin of the Amur and along the Sea of Japan. The chief tributaries of the Amur explored under the directions of Anosof are:—left tributaries: Urushi, Oldoi, Burinda, Zéhya, Zavitaya, Buréhya, Bidjan and Kur; right tributaries: the Ussuri, with the system of lake Hanka; and the rivers emptying into the Sea of Japan.

1st Group.—Left tributaries of the Amur:—

(*a*) Affluents of the Amazar in the Nerchinsk district: the Lesser Amazar and its tributaries the Tomirol, Kavikta, and Amgun. Left tributaries of the Amazar: Jalinda, Dador, Vassiliefka, Mogocha, with the Ilynika, Greater and Lesser Mogocha, the Greater Chichatka, with its affluent the Kulla.

(*b*) In the Amursky district, the following have been prospected:

(1) The Urka, with its left tributaries the Urulmutti and Omudichi.

(2) The Urushi, with 3 locations worked since 1870, yielding 28 lb. per annum, but liable to inundation.

(3) The Oldoi, 100 *versts* (60 miles) from its mouth, divides into the Upper or Greater Oldoi, flowing from N. to S. and rising in some lofty peaks of the Stanovoi range, near the Larba (belonging to the basin of the Olekma); and the Lesser Oldoi flowing from N.E. to S.W., rising in the Yankan range. The Greater Oldoi receives on the right the river

Mongoli, with 6 locations. In one boring, about ¼ lb. of gold was found, and the precious metal apparently lay in nests, but the remoteness of these workings made them unprofitable to work; the river Molodan, with its feeders the Modolakan and Udikit, both discovered by Anosof, with an average yield of 1 to 1⅓ *zolotniks* (65 to 90 gr.), but the gold is in nests, and the belt of alluvium is narrow; the Sivagli and the Shekshaun, with 2 locations. Gold is more abundant on the Lesser Oldoi. Here Anosof found in the Yankan a knot of auriferous rocks from which radiate belts of alluvial deposits along the rivers Krestofka (falling into the Oldoi), the Ura and Gilni, right affluents of the Zéhya. The Krestofka falls into the Lesser Oldoi on the left, after receiving its right tributary the Yankan, upon a feeder of which, the Baldijak, are two placers. There are 4 locations on the Yankan; 2 of these, worked by the Upper Amur Company, yielded in 1871–76, 5400 lb., in the proportion of 2 *zolotniks* 59½ *doilias* (170 gr.) per 3600 lb.

(4) The river Never, with its affluent the Uldigichi, with 6 locations.

(5) The Assejina, with 2 locations on each of its tributaries, the Burgali and Depak.

(6) The Burgali, with 4 placers, yielding on an average about 1 *zolotnik* (65 gr.) per 100 *puds* (3600 lb.).

(7) The Zéhya has a course of upwards of 1300 miles, and receives numerous streams flowing from the Stanovoi range and its spurs, which are liable to sudden floods, when the snows melt in the mountains, and during the rainy season in summer. The Zéhya has been very insufficiently explored, and but few borings have been made, though, judging from the discoveries of the Trans-Baikal expedition (in 1849), it is expected that much gold will be found along its northern affluents.

The right affluents of the Zéhya, between Blagoveschensk and the mouth of the Ur, passing through Tertiary formations, are not auriferous so far as they are known. It is along the upper right tributaries of this river, which have their sources in the Yankan, Tukuringir, and Gilni ranges, that most of the gold has been found. The left feeders are but little known; but the general rule is—the nearer to the mountains, the better the chance of the gold-seeker, e. g. the Djagdu, Buréhya, Lesser Hingan, and Ud chains.

A. Right tributaries of the Zéhya:

(1) The Ur or Urkan: auriferous detritus was discovered on its upper right tributary, the Ingagli, which gave 20 *zolotniks* 8 *doilias* (1321 gr.) per 3600 lb.; and the Jalinda, upon which 20 locations have been claimed by the Upper Amur Co. Between 1868 and 1876, the Jalinda diggings yielded 35,124 lb. of gold, with an average yield of 2 *zolotniks* 26 *doilias* (149 gr.) per 3600 lb. The Jalinda works are considered the best in the country, and not half the gold is exhausted. The other diggings on the

Ur are not rich. The detritus on the Jalinda lies on beds of diorite, whilst on some of the neighbouring hills syenite and granites crop out, and farther south, argillaceous and talcose schists, associated with limestones, are the prevailing formation.

(2) The Gilni : the following right affluents of this river are reported to yield gold,—the Mogota and Tanda, with 5 localities ; the Jeltulak, with 4, yielding as much as 3 *zolotniks* 12 *doilias* (205 gr.) per 3600 lb. of sand, and extending for 12 miles in length.

(3) The lesser tributaries of the Zéhya, between the Gilni and the Brianta, are auriferous, though to what extent is unknown ; their names are : the Ulenkit-Ulaghir, Jakda-Ulaghir, Ushakda-Ulaghir, Kongamun-Ulaghir, Mogota, Ugana, and Dambikeh.

(4) The Brianta is joined on the right by the Ilikana, along which and its feeders, several localities were discovered in 1873, with an average yield of 1 *zolotnik* 60 *doilias* (108 gr.) per 3600 lb.

(5) The Bomnak, with 5 localities, extending 17 miles in length, but too poor and remote to repay the cost of working.

B. Left affluents of the Zéhya :

(1) The Kupuri has poor detritus at its mouth, but higher up on its left affluent, the Kinlianjaku, alluvium was found by Anosof, yielding 1½ *zolotniks* (99 gr.) per 3600 lb. Below the Kupuri was no gold as far as the Siliniji, excepting a few traces of the precious metal on the Megu.

(2) The Siliniji has several series of deposits on its right tributaries ; these are—

(a) The Mara, with 12 localities on its left feeder the Burunda giving traces of gold.

(b) The lower Mina, with its tributaries : the Tiksiana, 4 localities, average yield, 21 *doilias* (14¼ gr.) per 3600 lb ; Melannir, with 3 localities, 18 *doilias* (12¼ gr.) per 3600 lb. ; Usiakannir, with 2 localities, 24 *doilias* (16¼ gr.) per 3600 lb ; altogether, on Lower Mina, 11 localities, 33 miles long ; average, 19½ *doilias* (13 gr.) per 3600 lb.

(c) The Inkan, with its feeders : the Begin, 3 localities, Sabas, 2 localities, and one on the Inkan itself ; in all, 6 localities on the Inkan ; length, 20 miles ; average yield, 18 gr.

(d) Upper Mina, with its feeders : right source of the Upper Mina and its affluent the Nika, 4 localities, 12 miles, yield 24 *doilias* (16¼ gr.), Bakadja, 2 localities ; Murtijak, a spring unnamed, and on the left Lukachok, Bagalannak, altogether 12 localities, 30 miles ; average yield, 21¾ *doilias* (15 gr.) ; making a total on both Mina rivers and Inkan of 29 localities, 87 miles, average breadth ½ *verst* (¼ mile), yield, 20 *doilias* (13 gr.). The placers on the Siliniji are but little explored, and only one, viz. that on the Bakadja, is worked. This yielded in 1875 432 lb. of gold, and the further development of this gold-field will depend on future explorations.

Traces of the metal were discovered near the sources of the Siliniji, on the Maergin, in 4 localities, with an average yield of 94⅓ *doilias* (64 gr.).

(8) The Buréhya. Very rich deposits were discovered on the Niman falling into the Buréhya on the right, and its feeders, the Olga, Toen-Olga, Elan-Bira, Topko-Bira, and Utchugei; also on the Elga and the left affluents of the Olga, e. g. one locality on the Agda, 89 *doilias* (60¼ gr.) per 3600 lb.; another on the Konaka, 3 *zolotniks* 61 *doilias* (230 gr.); one on the Olga, 38 *zolotniks* 72 *doilias* (300 gr.); traces of gold on the Salara. The Olga is joined on the right by the Olgakana, and its left tributaries, the Utchugei and Artik; in all, 60 auriferous localities were reported, and further searches have yet to be made on the Niman.

Below the confluence of the Buréhya with the Amur, exploring parties under Anosof and Basuin found detritus with traces of gold in a defile in the Hingan mountains, on the river Zimoveinoye; but none on the Dichuna and Bidjan, and only traces of it on the Kukana, a left tributary of the Unma, an affluent of the Kur.

(9) The Amgun and its tributaries rise in the lesser Hingan range, but exploration has not penetrated far here, owing to the thinness of the population, chiefly composed of Nigidaltsi, Shamageri and Giliaks. The valley of the Amgun is mostly of recent geological formation, sandstones lying near its head-waters, and granites from its source to the Kerbi. A left tributary of the Amgun, the Herpuchi, is, however, known to be auriferous, and gold has been washed from the detritus on the Talmak, one of its right tributaries. The placers here are owned by Tintinkoff, Benardaki, and Periaslavtsef, and 132 lb. of gold are annually produced at the mines of Tintinkoff, who has a claim on the Hon, a left feeder of the Herpuchi, with poor detritus. But on the Upper Hon, 3 miles from the Giliak village of the same name, there is a locality from which gold is obtained in the rich proportion of 10 *zolotniks* (658 gr.) per 3600 lb.

(10) The lake system of the Amur.

Below the lesser Hingan range, especially from Khabarofka downwards, the Amur flows through lowlands, and only enters the hilly country between Lophiisky and the mouth of the Amgun, where it is crossed by the spurs of the Sihotu-alin. Along the whole extent of low-lying land are scattered lakes, all more or less closely connected by channels with the river, e. g. the Jaghini [Shamagher], Ehvoron, Sargu, Bolon, Udil, Chan, Oriol, Chilika, Kizi, Kada, Chlia, and others; in some of these lakes, gold has been found.

(a) Lake Sargu, near Malmijsky village, is joined by the Béha, with detritus yielding 1½ *zolotniks* (99 gr.) per 3600 lb., located by Sumkin: and the Kupchul, 12 miles from the lake, with detritus averaging 2 *zolotniks* 58 *doilias* (171 gr.) per 3600 lb., located by Cherdimof.

(b) Lake Udil, below Sóplinsek and above the mouth of the Amgun, 30 miles from the Giliak village of Joloka, is joined by the Alokcha, with detritus averaging 58 *doilias* (39½ gr.) per 3600 lb.; and by the Bitki, with its affluent the Balakai, both located by Luri.

(c) Lake Chilika is joined by the Kirgichan, with traces of gold.

2nd Group: right affluent of the Amur; system of the Ussuri and lake Hanka.

The Upper Ussuri was prospected by Basuin in 1861–62, but no gold was found, except on the Imma, where 8 borings were sunk, in one of which a nugget was found. But these searches were not extensive enough, because they did not reach the Sihotu-alin mountains, and they were moreover made under exceptionally unfavourable conditions, owing to the thinly settled population at that time, and the dearness of necessaries of life. The forests and marshes too are impenetrable in the winter months, owing to the depth of snow. Hence traces of gold were discovered only on two tributaries of lake Hanka, in some abandoned diggings surreptitiously worked by the Chinese.

3rd Group: the littoral of the Pacific.

(A) The sea coast of Okhotsk and Tatarsky Gulf. Between Udsky Bay and De Castries Straits, the coast-line of the Pacific is upwards of 1000 *versts* (725 miles) long, and is watered by numerous rivers, the chief of which are the Ud, Tugur, and Amur. It is a belt of territory indented with rocky bays, with steep precipitous cliffs abutting on the sea, and here and there a shelving sandy slip subject to frequent inundations by flood and tide. The population is scarce, consisting of fish-eating Giliaks, who drive their dog-sledges through the deep snow in winter, and in summer urge their light birch-bark skiffs, so-called *omorotchi*, from island to island. Communications are thus kept up without great difficulty; specially easy is that from the Tugur to Ukakyt, near Burukunsky chapel, on the Agnekan, a left affluent of the Nemilen, flowing into the Amgun on the left. This was the route followed by Cossacks and hunters to the scenes of their early triumphs on the Amur in the latter half of the eighteenth century. In 1851, detachments of the Trans-Baikal expedition explored the shores of the Sea of Okhotsk, and discovered traces of gold along the rivulets discharging into that sea, between the mouths of the Ud and Tugur. Koranko, who took part in this expedition, ascended the Ud from Udsk to the Shevli in a skiff, and found traces of gold on the Ugakan, a tributary of the Shevli. In 1872, 4 placers were located here by Anosof, and traces of gold were also found north of Nikolaiefsk, on the Greater and Lesser Iskai, and on the Shilho, an affluent of the Mindu.

(B) Shores of the Sea of Japan as far as the frontier of Corea.

That tract of country lying between De Castries Bay and Plastun has never been prospected for gold. At Cape Zolotoi (Golden), visited by the Russians for the first time in 1874, gold was found, and probably the mineral wealth of the whole region will repay a careful survey. In the southern maritime districts, gold was found in old Chinese and Manchu workings, the industry having been carried on by the former people in contravention of the law. It seems, however, that the yield was extremely poor. In 1873, claims were started at several localities along the bays; but owing to insufficient data, it is difficult to judge of the richness of the detritus. The following is a list of allotted placers :

(1) On the Tu-su-uga, and its tributary the Sio-su-su-ta-sio-si-hor, one claim yielded 55 *doilias* (37½ gr.) per 3600 lb.

(2) Ta-vai-tsa Bay, between Ostrof Gulf and Shallow Bay, is joined by the Su-du-ho; into its tributary the Sian-su-tsz-ho, falls on the left the Chin-tin-kan, with a claim of 37 *doilias* (25 gr.) per 3600 lb. The Sian-su-tsz-ho has 4 claims of 25 to 40 *doilias* (17 to 27¼ gr.).

(3) The Ching-cheng-su-ai has one claim of 40 *doilias* (27¼ gr.).

(4) America Bay is joined by the Suchan: its tributaries are the Eldogu [Erdogu], into which flows the Eldogoga, with 1 claim 20 miles from the Chinese village of Pinsan, yielding 80 *doilias* (54½ gr.) per 3600 lb. The Shu-su-ho has another claim of 68 *doilias* (46¼ gr.); the Suchan, with its affluent the Great Sicha, has a claim of 2 *zolotniks* 48 *doilias* (164 gr.) per 3600 lb.; the Shisa, falling into the Suchan, has a claim of 1 *zolotnik* 44 *doilias* (68 gr.) per 3600 lb., 17 miles from the village of Pinsan. The Fonga, a left tributary of the Suchou, has 1 claim yielding 30 *doilias* (20¼ gr.).

(5) Nahodka Bay: 1 claim on the Finsk, of 40 *doilias* (66 gr.).

(6) Vostok Gulf, to the west of America Bay, is joined by

(a) The Udmi, with its tributary the Chin-san-sahoi; into the latter flows Sadingo brook, with a claim averaging only 20 *doilias* (13½ gr.).

(b) The Ta-Udmi, with its left affluent the Singak, with its tributary the Meskokh, with 2 claims on each.

(7) Strélok Straits receive the waters of the Seveiza, on the left source of which 1 claim has been opened, with 20 *doilias* (13½ gr.); the Tian-tundza with one claim, of 27 *doilias* (18½ gr.), the Kogotun falling into Abrek Bay, with two placers, averaging 20 to 30 *doilias* (13½ to 20½ gr.), and a third on a spring flowing into it.

The Tin-ha or Chen-hen, upon which Anosof discovered abandoned workings, with a yield of 1 *zolotnik* (66 gr.) per 3600 lb. The belt of detritus extends for 20 miles, and has been quite recently worked by Chinese. The alluvium continues to the sea, and probably lies beneath it.

(8) Ussuri Gulf is joined by

The Shitakha, with its tributaries the Pinkan, fed by the Tin-ho, upon which there is a claim. The Endologa joins the Shitakha from the left, and was prospected by Basuin, who also explored the Kongonza, where he found traces of gold formerly worked ; the Tsimaha, with its affluent the Shitun and Pestsi ; the Maiha or Mach-ho, with its right tributary the Suidengu, with a claim about 20 miles from the village of Shkotovo, containing gold in small quantities.

(9) Amursky Gulf receives a nameless river with 1 claim averaging 30 *doilias* (20½ gr.) ; the Suifun : this river rises in Manchuria, in the Chang-pe-ghan mountains, near the Tumen-ula and the rivers debouching into lake Hanka. Near its sources, Chinese engage, it is reported, in the contraband industry ; of 3 placers opened within Russian territory, on the Potaheza, a tributary of the Suifun, Lansky owns one averaging 70 *doilias* (47½ gr.) ; 2 others on a branch of the Potaheza, called after the Mantsi, yield 55 and 50 *doilias* (37½ and 34 gr.) respectively ; and a fourth, below the confluence of the Hubutu-Ulatu, on the Manchurian border, has a claim of 1 *zolotnik* 54 *doilias* (102½ gr.). The other streams flowing into Amursky Gulf, viz. the Ili-ho, Ambo-bellu [Amba-bira], and Manguhai, were surveyed by Lopatin, but no gold was discovered. The Yanchi-ho falling into Expedition Bay of Gulf Possiet contains traces of gold.

(10) Islands.

Between gulfs Olga and Amursky, at a short distance from the coast, are the islands Askold, Putiatin, and Petroff, containing alluvial deposits. These moreover evidently cross Strélok Straits from the Tsimaha to the islands in the Sea of Japan.

(a) Askold Island is separated from the continent by Strélok Straits. In 1868, some Mantsi inhabiting the maritime districts washed gold on this island, and 5½ lb. of the precious metal was taken from them ; 300 of these people worked in 5 trenches or dykes 14 ft. wide, and in 6 pits 10 ft. deep, in the direction of the sea coast. They had built themselves huts, and washed the sand in 5 hand-buddles. From Basuin's report, the auriferous stratum appears to lie close to the shore, and even under the sea ; and Lopatin found it to extend along the south side of the island, where it was met with in Naiesdnik (rider) Bay, and along a dry gully leading from it. The stratum was in one place 5 to 10 ft. thick, and contained 4 gr. of gold in 10 *puds* (360 lb.) of sand, without any overlying peat. Other borings showed a thinner stratum, and a smaller proportion of the precious metal.

(b) Putiatin Island lies north of Askold Island, and was surveyed by Basuin in 1868, when he found some old Chinese workings so completely overgrown with grass and bushes that they were scarcely visible. A chain of hills runs across this island, which is 2 miles wide ; 300 yd. from their foot, at the confluence of some springs, lies a narrow belt of auriferous sand, under a thick layer of peat. The Mantsi reported there were other diggings in the south of the island, which forms a link in the chain of hills extending from the mainland southward to Askold Island. On the S.W. slope, a claim has been located for a distance of 1000 yd. in Tulbo-bai ravine, yielding 1 *doilia* (0·68 gr.) per 100 lb.

(c) Petroff Island lies near Ta-vai-tsa and Cape Ostrofny, and has one claim.

(d) Russky (Russian) or Dundas Island, opposite Golden Horn Bay, is reported to be auriferous.

General Summary.—The gold industry in the Amur country was first commenced by the Upper Amursky Company, and has been successfully developed along the Zéhya, Buréhya, and Amgun rivers. Its importance, long checked by the scantiness of the population, promises in the future to become great; but the necessaries of life have all at present to be brought from Trans-Baikalia, whence they are transported on rafts and in boats down the Shilka and Argun to the residence or depôt of the Upper Amur mining districts, ⅔ mile from the village of Rainovo, on the Amur. Here is a landing place and telegraph station, and hence supplies are carried in winter on camels to the diggings of the Upper Amur Co., distant 70 miles. Between 1868, when this Co. first started, and 1875, their production averaged annually 5060 lb. of gold, 10 diggings being worked on the rivers Ura and Oldoi by about 2000 men. The belt of alluvium is 7 ft. thick, and the overlying peat varies between 7 and 10 ft. Each of their double-barrelled machines washes 80 cub. fathoms per diem, and there are besides 6 stands.

The gold-fields of the Amur basin lie in Trans-Baikalia, the Amur and maritime provinces. Those on the upper Amur, and its tributaries the Shilka and Argun, are included in the Nerchinsk circuit; farther east, on the central Amur, as far as Kharabofka, they are comprised in the Amursky circuit; the remainder, on the lower Amur and its affluents, together with the littoral of the Pacific from Corea to Cape Chukotsky, are included in the Primorsky or maritime circuit, and are distributed over the whole province. These placers are of comparatively recent discovery, but they promise to become at a future day of great importance to the gold-industry, owing to the navigability of the rivers, and their easy access from the sea. They are situate in the mountainous tract margining the basin of the Amur on all sides, as well as in the littoral range of Sihotu-alin. The gold is disseminated along the courses of the chief affluents of the Amur, in numerous though not particularly rich beds of detritus, and is easily worked. Some of the alluvium lies actually on the sea-coast, e. g. on the islands in the sea of Japan, in Strélok Bay, and along the shore of the Sea of Okhotsk. The detritus of the Amur is generally not thicker than about 18 ft., but on the other hand it is sometimes nearly a mile in width. The proportions of peat and detritus are equal, and it may be said generally that a thin layer of vegetable mould barely covers the auriferous deposits. This leads to the inference that the disintegration of the rocks and dissemination of the gold were the result of very violent physical changes assisted by the steep fall of the rivulets and summer floods.

The gold-mines of Nerchinsk lie in the spurs of the Yablounovoi range, from the borders of Mongolia and Manchuria to the confluence of the Shilka and Argun. Many of the streams in the Nerchinsk circuit abound in gold of various richness, from hardly perceptible traces to *zolotniks* (1 *zolotnik* = 65·83 gr.) of it. The constantly frozen state of the soil has doubtless prevented the detritus from being washed away by the rivers; had it been otherwise, and the climate warmer, all the gold would have been carried down to the Eastern Ocean, and such has doubtless been the case in former times on a great scale. The modern auriferous detritus is therefore a remnant of the ancient placers. The depth of these deposits is not great.

Government began the search for gold in 1830; washing commenced in 1832. The following quantities were obtained at the Government placers:—

Washing years.	Alluvium washed.	Contents per 3600 lb.	Gold raised.	Average for the year.
	million tons.	dwt.	lb.	lb.
1832–35	0·01	1¼	34	8¼
1836–40	0·08	2¼	447	89
1841–45	0·24	3½	2,184	437
1846–50	0·73	3¼	6,484	1298
1851–55	1·8	4¼	19,881	3976
1856–60	2·2	2¼	12,279	2456
1861–65	3·26	2¼	17,645	3529
1866–70	4·4	2¼	25,718	5143
1871–73	3·0	2¼	16,414	5471
1874	0·85	2½	5,481	5481
	16·5	2½	106,567	

Up to 1863, gold-mining was done by serfs attached to the mining districts; from that date, by free labour, by which a larger quantity was produced.

In the Nerchinsk circuit is a vast extent of auriferous detritus lying idle owing to the poor yield of gold, rendering it impossible for private enterprise to wash with the high taxes now levied. Experience has shown the unprofitableness of washing detritus which yields less than ¾ *zolotnik* (2 dwt.) per 3600 lb. The total quantity of auriferous deposits, reckoning them at about 1300 miles in area, 350 ft. wide, and 7 ft. thick, is 50,000,000 cubic fathoms, estimated to contain 940,000 lb. of gold.

The private placers of the Nerchinsk circuit occupy the area from the Yablounovoi range to the Mongolian frontier on the east, to the Argun, along the tributaries of the Urunluingui and Central Borzeya, the Unda, Onon, and Shilka, the Kuenga, the Nercha, Urum, and Chacha. Government monopolized the gold-industry only till 1864, when private enterprise was admitted in certain parts of the district with successful results, and it is anticipated that when the whole of Nerchinsk is thrown open to private enterprise, the annual production will reach 18,000 lb.

The quantity now raised, 11,700 lb., must be considered small for so large and highly auriferous a tract as Nerchinsk. Various causes are assigned for this small production, droughts and flood, damages to hydraulic and other works by heavy rains in July and August. Permission too is much needed to seek for gold on the Achinga, Akna, Baldja, Kirkuna, and Kyr, still reserved for the Imperial private purse. Were these and other localities offered to individual enterprise, much of the poorer detritus now lying idle might be made to produce something.

The gold-fields on the Amur are situated on its tributaries the Zéhya and Buréhya, in spurs of the Stanovoi and Buréhya ranges. They present no remarkable or distinctive features, but may generally be described as large deposits not very rich in gold, which has been continuously disseminated along the valleys and low-lying lands bordering on the Amur. Up to 1875, claims were sent in to the mining authorities for 1000 running miles of placers. Some of the detritus on the Buréhya [Niman], Selimdja, Jalinda, and Zéhya, is nearly a mile wide, so that the auriferous localities claimed represent an area of 1000 sq. miles. It is estimated that if $\frac{1}{10}$th of this be worked, it should produce 585,936 lb. The rate of production in 1871–75 was 6048 lb. per annum at 6 placers, and the quantity raised by each individual labourer was 8 lb.

In quantity of work done and gold produced, the Upper Amur Co. surpasses all others in Siberia.

The sea-coast of the Eastern Ocean, from the borders of Corea to the mouth of the Ud, in the Sea of Okhotsk, is auriferous. There is doubtless gold too farther north, along the sea-board of Okhotsk and Behring seas to Cape Chukotsky, on the islands which stud these seas, and in Kamchatka. But in 1871, there was a great dearth of the necessaries of life in these regions, and this diminished the supply of gold. Up to 1874, 400 lb. had been raised; in that year, the only placers worked, viz. those on the Amgun, were neglected probably for the same reason. In 1875 and 1876, searching parties prosecuted their work in several localities along the Sea of Japan; and in 1877, washing was commenced on Askold Island. The same year, the production of gold in the maritime province reached 461 lb.

According to an estimate by Bogoliubsky, the basin of the Amur contains 250,000,000 cub. fathoms of auriferous soil, from which 5,859,380 lb. of gold may be raised; under more favourable conditions, however, this quantity may be largely exceeded. Between 1832 and 1875, the quantity of gold raised in the Amur basin was as follows :—

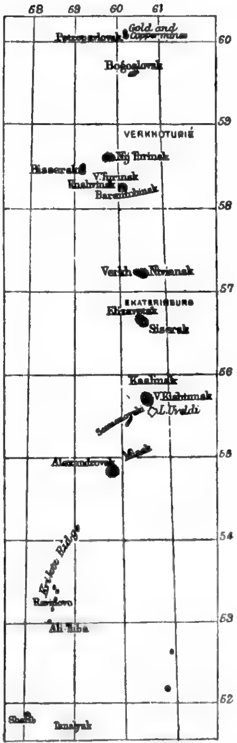
	lb.
Okrug (circuit) of Nerchinsk, private estates of the Tzar	106,560
Do do private enterprise	48,054
Do Amur	34,500
Do Maritime province	400
	189,514

From 1861, gold-washing in the basin of the Amur took a new start, and has proceeded satisfactorily ever since; whilst on the eastern seaboard, the field for the development of minerals is wide. Kamchatka, Saghalien, the Shantar and Kurile islands, are nearly inaccessible, and their gold-fields cannot for the present be explored; but with the settlement of the maritime province by an agricultural and industrial population, an abundant supply of the necessaries of life will be assured, and the treasure lavishly scattered along the shores of the Great Ocean will become available.

In 1875, gold-washing was begun on the Siliniji by the Central Amur Co., and about 412 lb. was obtained. In the same year, operations were also commenced on the Buréhya, Niman, and Olga; but no returns are available for that year. In 1871, Tintinkoff opened his diggings along the Herpuchi and Talmak, obtaining on an average 144 lb. per annum in 1874–75. Altogether, the basin of the Amur had yielded up to 1875, 41,760 lb. of gold, valued at 15,080,000 metallic *rubles*, or about 2,500,000*l.*, but this is exclusive of the production on the Shilka, in the Nerchinsk district, which alone amounted to 16,380 lb. to 1875, making a grand total of 58,140 lb., worth about 3,500,000*l.* This represents the profits derived from the Amur country, and is some return for the outlay in acquiring and settling it; but it is confidently anticipated that the future will yield far more brilliant results, and it is worth while estimating what there may be, by assuming the auriferous alluvial deposits to extend 1000 miles in length, with an average width of 350 ft. and a depth of 5 ft., yielding a proportion of ¼ *zolotnik* (16½ gr.) per 3600 lb.; say, cubic contents of detritus, 25,000,000 ft. of sand, producing 5,953,630 lb., value 2 milliards of *rubles* silver, or, in round numbers, 350,000,000*l.* Of course, while the duty remains so high and other conditions so unfavourable, it is impossible to work areas returning a low proportion of gold. But the time will come when the country will be opened up and inhabited by a settled population. When agriculture and industry thrive, it is possible that these estimates may be largely surpassed, for it should be remembered that only one-half the basin of the Amur is as yet explored.

The Ural Gold-fields.—The "Arctic Ural" extends from the 61st parallel northwards for 1000 *versts* (about 670 miles) to the shores of the glacial ocean. It is for the most part densely forested, almost impassable, and characterized by an extremely severe climate. This tract was explored by the so-called "Northern Expedition," in 1830–43,* and gold was discovered on the head-waters of the rivers Petchora, Vishera, Shigor, and Vychegda, which rise in the Ural, and along the basin of the northern Sosva, where the Pai-hoi range begins. From experiments then made, the average yield was found to be about 1 *zolotnik* (66 gr.) per 100 *puds* (3600 lb.) of sand and earth. But the region is so remote, inaccessible, and devoid of the necessaries of life, that miners cannot venture into it, and its gold is therefore practically useless. The following remarks concern the better known colonized parts of the Ural range, southward from the 60th parallel of N. lat. nearly to Orenburg. When Murchison, Count Keyserling, and De Verneuil explored this country in 1841, and published their great work on its geology, gold-mining was in its early stage of development, the alluvial deposits were only beginning to be worked, and washing was entirely done by hand, with the assistance of horses and oxen. In the 40 years that have elapsed since then, many remarkable changes have taken place, to which allusion will be made in the following pages, and it is probable that no part of Russia can show so much progress as the towns, *zavods* (ironworks), and mining centres in the Ural do at the present day.

FIG. 13.



URAL GOLD-FIELD.

The Ural gold-mines and placers are of two kinds, those belonging to Government, and those owned by private individuals. To the former category belong the Bogoslofsk, Goro Blagodat, Ekaterinburg, and Zlataust groups; in the latter, are included all gold-washings and -diggings belonging to private companies and individuals, situate on both flanks of the range, but mostly on the eastern [Asiatic] side, in the governments of Perm, Orenburg, and Ufa, as well as in the Uralsk territory.

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* Also by Murchison's associate, Count Keyserling, in 1843, who discovered a north-westerly ramification of the Ural, the so-called "Timan" range.

A. The Government gold-fields.—(1) Bogoslofsk is the northernmost of the Government mining establishments in the Ural. It was formerly noted for its production of iron and copper, but this source of prosperity declined so materially that in 1837 the works would have been closed, had not rich gold-alluvions been discovered. Sir R. Murchison says that the Peschanka gold-mine, near Bogoslofsk, had yielded from its discovery in 1829 to 1840, i.e. in 11 years, 250 *puds* (9000 lb.) of gold. According to another writer, 112 placers had been opened to 1849, and the annual washings averaged 1500 lb., with a proportion of ⅔ *zolotnik* (44 gr.) to 3600 lb. of sand. The gold lies along the Lozva and Sosva, tributaries of the Tavda, an affluent of the Tobol, and is associated with diorite, serpentine, and sulphur-pyrites. Murchison found the chief underlying rock to be greenstone, and the richest alluvions lay immediately upon it. No quartz veins have been found here, the gold grains being simply collected by washing the finer sandy gravel. "The inspection of this locality," says Murchison, "led us to believe that the gold had been diffused through the subjacent rock, and that the auriferous epoch, or the close of it, was marked by the scouring and denudation of the surfaces of the rock so impregnated." The following details of production are borrowed from Bogoliubsky's work :

Years.	Gold raised.	Average annual quantity.	Average for the year.
	puds.	*puds.*	lb.
1823–60	1328·3	34·95	1262
1861-65	114·6	22·9	826
1866–70	112·925	22·6	814
1871–73	64·4	21·275	773
1874	14·925	14·925	541
	1635·150		

The falling off in the production after 1860 is attributed to the impoverishment of the placers owing to the removal of the richest sands, the enfranchisement of the mining population, and the introduction of *accord-arbeit.*[*]

The Bogoslofsk mining district is now rented from the Government by Bachmakof and Co., who have also undertaken the copper-mines there. An approximate calculation has been made by Bogoliubsky of the supply of gold in the 200 placers of the Bogoslofsk district. These he estimates at 1000 *versts* (725 miles) in length, with a breadth of 350 ft., a depth of 7 ft., and contents of 25,000,000 cub. fathoms, yielding 13,020 *puds*

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[*] The *accord-arbeit*, which might be compared with piece-work as distinguished from time-work, should increase the production and not diminish it.—M.

(468,720 lb.) of gold, in the proportion of 2 *zolotniks* (131½ gr.) per cub. fathom of sand. Deducting the quantities extracted before 1875, the remainder is 11,385 *puds* (409,860 lb.), and supposing half that quantity to be ultimately obtained, the value of the Bogoslofsk placers may be represented by the sum of 12,392,000*l.*

(2) The next Government mining district is Goro Blagodat, nearly due south of Bogoslofsk, on the same side of the main axis of the Ural, in the government of Perm. This district, which also comprises some large iron-foundries and gun-factories, first came into notice with the discovery, in 1730, of the rich hill of Blagodat (i. e. bountiful) famed for its magnetic iron-ore, and not less memorable for the tragic event connected with the early settlement of the Russians in this country, mentioned by Murchison. The Kushvinsky gold-diggings in this district brought the Government an annual revenue of 105,803 *rubles* (13,225*l.*). What has been done there more recently it is impossible to say, for since the admission of private enterprise in 1861, nothing is known of the results, no returns are published, and there is a complete absence of information about it, which is all the more surprising because the region is believed to be particularly rich in minerals, and covers an area of about 2 million acres, including the main axis of the Ural and its branches. Moreover, the position of this gold-field, the proximity of numerous Government and private iron-works, make it much easier to supply with all necessary instruments and machines than the Bogoslofsk *okrug*, which is out of the way and ill-provided with communications.

(3) The Ekaterinburg group occupies the central Ural, and is important, no less from the town after which it takes its name, than for the *zavods* or works in the vicinity. Besides, it is easily accessible, being on the great Siberian highway, and for the last few years it has been connected with European Russia by a railroad. Within 2 hours' drive of Ekaterinburg, are the gold-mines of Beriozofsk, discovered in 1745, on the Beriozofka rivulet, a feeder of the Pyshma, by a peasant, Dorothy Markof. In those days, gold-washing was not understood, and attention was therefore exclusively turned towards quartz-crushing. In this way, 16 lb. of gold was obtained to 1754. Not till 1814, was an atttempt made to wash the alluvions. Murchison visited Beriozofka mines in 1841, by which time 679 *puds* (24,444 lb.) of gold had altogether been obtained from 52,000,000 *puds* (8,300,000 tons) of ore-stuff. He says they are interesting to the geologist and mineralogist, in offering the only subterranean shafts in all this region, by which gold is still extracted from the parent rock. The chief fundamental rocks are talcose and chloritic schists and clay-slates, like those which prevail around Ekaterinburg, and these have been cut through by bands of a felspathic rock, called beresite, which Rose considers to be a decomposed granite—a continuation, in fact,

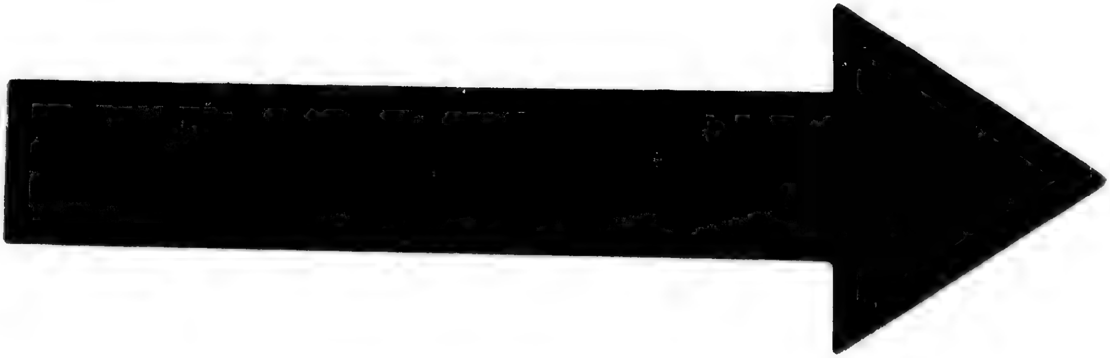
of the granites of the Shartash lake and Ekaterinburg. The writer descended this mine in 1861 by a lateral gallery, and saw the process of extracting the alluvium by a shaft only 28 ft. deep. The soil or gravel was poor, much poorer than that formerly worked, yielding only about a third of a zolotnik instead of 2 to 2½ zolotniks as formerly. Murchison mentions the maximum depth reached in his time as 28 fathoms (196 ft.), but these deeper borings were closed in 1861, owing to water, which made its way in from lake Shartash. Up to that year (1861), but little improvement had taken place in the art of washing the alluvium and quartz crushing; the machinery was of the rudest kind, and economy of labour did not appear to be studied, though steam power had certainly been introduced, and thus 10,000 *puds* (360,000 lb.) of ore-stuff were washed per diem. But the director said that a second and even third washing produced better results than the first. In Hoffmann's time (1843), it took 28 million *puds* of sand to produce the annual quantity of 30 *puds* of gold which was formerly obtained from 6 to 8 million *puds*. From 1814 to 1874, 2201 *puds* (79,236 lb.) of gold had been extracted from these mines. But the Ekaterinburg washings were eclipsed by those of Eastern Siberia, where superior energy and enterprise made up for remoteness and other disadvantages. Beriozofsk has, within the last few years, with other Government establishments of the kind, passed into private hands, and is said to be doing well, its production having risen to 2160 lb. per annum. This gold, however, is mixed with a large quantity of alloy, in the proportion of about 12 per cent. There is said to be enough alluvium to last for many years in the valleys which join the Pyshma, Reft, and Isset.

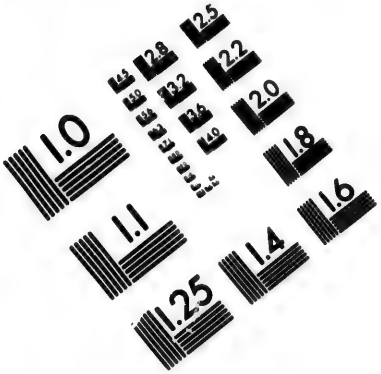
(4) In the southern Ural lies the highly metalliferous region of Zlataust (golden mouth), amidst ridges of hills, some of which rise to a height of several thousand feet. Zlataust itself (the town and the works) lies in 55° 11′ N. lat., and 77° 26′ E. long., 1230 ft. above sea-level, surrounded on all sides by hills wooded to their summits. In 1863, the population here numbered 25,708 males, mostly employed in the Government works. The gold-alluvium is found along the lateral streams which feed the Miass, a river flowing from S. to N. in a valley bounded on the W. by the main crest of the Ural, and on the E. by the Ilmen ridge, remarkable for the minerals and precious stones found there. The Miask diggings have been from the first among the richest in the Ural, both in the quantity of the gold found there and in nuggets. The largest of these weighed 79 lb., was found at the Tsarevo Alexandrofsk digging; it may now be seen at the museum of the mining corps at St. Petersburg. After the discovery of the Miask placers in 1823, their production rose so rapidly, that in 1827, 64 *puds* (2304 lb.) were extracted from them. Between this and 1849, the annual yield averaged about 50 *puds*

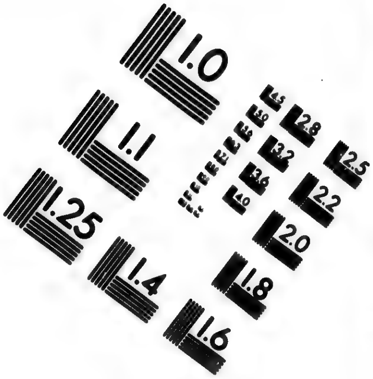
(1800 lb.), and remained stationary at this for 10 years; but in 1859, it suddenly fell to 33·57 *puds* (1213 lb.).

Regulations and Statistics.—A serious decline in the prosperity of the Miask works induced Government to try an innovation in the mode of working them; as this has exercised a great influence on the gold-industry in Russia, and is still generally practised, it will be necessary to say something about it. Up to this time, the workmen at the mines, both Government and private, had their tasks allotted to them by overseers or *steigers*, as they were called after the German. These overseers were responsible for the conduct of the work, and were entrusted with the supervision of the men, who were paid for their labour by the day. Finding this system did not answer, and that the production of gold unaccountably declined, it was decided to adopt the system of piece-work, that is to say, leaving the men to work the diggings as they pleased, and to give them a small share in the gold washed, irrespective of the amount of work done and the time they took about it. This was called *staratelskaya rabota*, i. e. "zealous work" (the word *staratsa* meaning to strive or endeavour), and bore some analogy to the *accord-arbeit* in agricultural holdings in northern Germany, whence the idea was apparently borrowed. This system, useful as it doubtless was in its results, was not without its disadvantages. And these have always been and are still strongly urged against it. Admitted that the production of gold was increased, and that the work done both in the aggregate and by each individual labourer was vastly in excess of anything previously heard of or thought possible, and this with the rudest implements and the most primitive machinery, it was found on the other hand that it led to an unsystematic working of the placers. The appearance presented by these after a gang of volunteers had been washing was that of confused heaps and holes, which rendered them useless afterwards, though the alluvium may not nearly have been exhausted. The *steigers* who conducted the preliminary work of boring were tempted to conceal the position of the best alluvium, in order that they might work them with the *accord-arbeit*, in whose gains they took care to reserve a share for themselves. It encouraged gold-stealing, owing to the impossibility of exercising sufficient control over the men, who were often scattered over a wide area, washing in small gangs, or each man for himself. It fostered negligence on the part of the overseers and immorality among the men, yet in spite of this, no better plan could at the time be devised for restoring prosperity to the diggings, which had become an important element of national wealth. When the Ural placers were first discovered, the search for gold was restricted to owners of *zavods* or copper- and iron-works, who were allowed to prospect for the precious metal on their estates. But as reports of a much wider extent of gold-fields received confirmation, it became doubtful if the exclusiveness hitherto adopted were really beneficial. On the one side, it was said that great evils might result from a large influx of gold in districts so thinly populated as most parts of Siberia; it was feared that artizans and labourers, of whom there was already a dearth, might be only too ready to leave their employers and seek their fortunes at the diggings, thus depriving the Government of the hands necessary for carrying on their work. Moreover, it was alleged that the gold-fields would be wastefully worked by numerically weak gangs of miners, and that a contraband trade would spring into existence.

By those who held these views, Government was advised not to surrender its hold over the minerals, but to keep them until such time as they would be indispensable for the state. On the other hand, it was contended that labour was not so scarce as was alleged, that the iron-works and coal-mines in the Ural and Siberia might take care of themselves, and that only a small proportion of the working classes was employed at the private gold-diggings. It was pointed out that private enterprise and capital had already done much for the gold-industry, and would probably do a great deal more towards developing it, and that the interference of the state did more harm than good. These views found an able exponent in an anonymous writer, who is generally believed to have been no less a personage than Count Canerine, minister of state. He exposed the fallacy of endeavouring to hamper by Government restrictions a new branch of industry. What, he asked, are these gold-alluvia, these masses of earth and sand, but disintegrated fragments of rocks drifted by streams of water into the valleys and widely disseminated. The process which had formed them was still at work, distributing the precious metal over a still wider area, and impoverishing the detritus. By reserving the washings for future use, the state would be the loser, not the gainer, and every effort should be made to utilize them with all possible speed. These arguments prevailed, and in 1826 permission was given to every Russian subject recommended by the minister of finance to prospect for gold. In this way, the merchants Rézantsof, Rézanof, Cherepanof, and Verkhodanof were allowed to prospect the Crown lands in the governments of Viatka and Tobolsk. In 1827, the merchants Korobkof, A. Popof, and W. Popof, received like concessions for the government of Viatka, Siberia, and Omsk, as well as the governments of Archangel and Vologda, whilst councillor Prince Galitsin was allowed to explore those of Irkutsk and Yeniseisk. In 1828, permits were given to merchants Kuznetsof for Irkutsk, and another Kuznetsof for Kunghur, Balandin for Tomsk, Irkutsk, and Yeniseisk. In 1829, the Semipalatinsk merchant Popof received like privileges for W. Siberia, including the districts round Omsk. Thus, by 1838, 200 persons who







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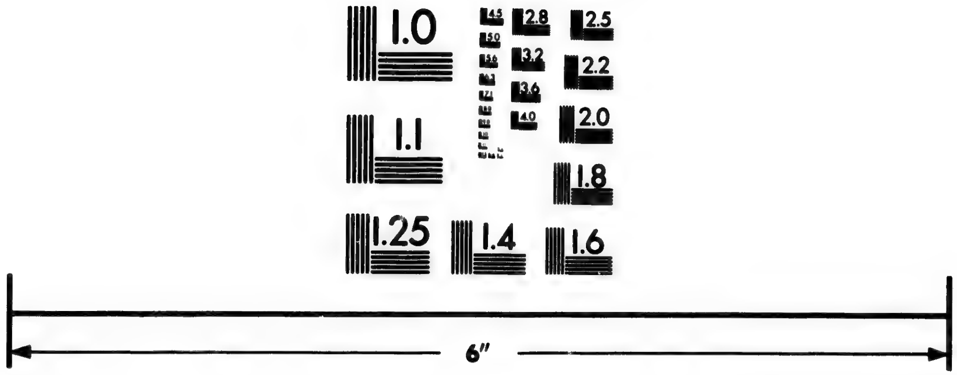

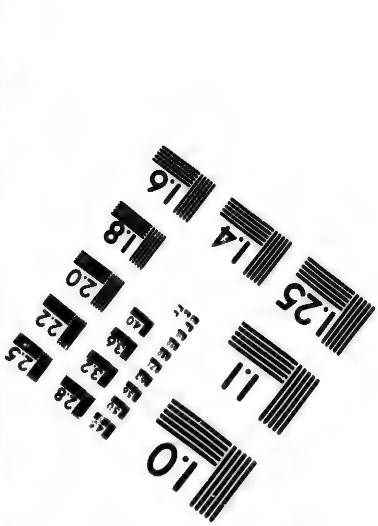

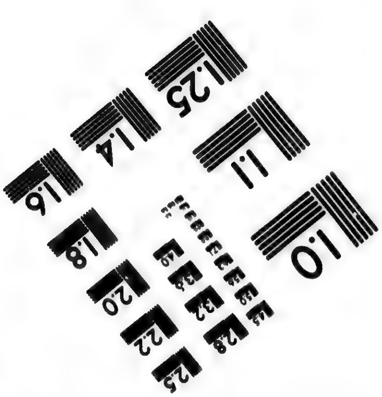

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had meanwhile found a corresponding number of placers embarked in the industry. Private gold-workings in Siberia were at first taxed, like those in the Ural, with an *ad valorem* duty of 0·15, levied in kind, besides 4 *rubles* (10*s.*) per lb.[*] or 0·0121 of the value for maintaining a staff of police at the diggings. This was modified in 1838 by a Government edict revising the administration of the Siberian gold-workings.

The discovery of extraordinarily rich workings on the Uderey, in the government of Yeniseisk, in 60° 5′ to 61° N. lat., and 95° 5′ long. E. of Paris, barely 3 years after the publication of this edict, led to a thorough change in the system. From December 1840, the washings on the Uderey were taxed with 0·24, in all other parts of Eastern and Western Siberia with 0·20, of the value of the extracted gold, besides the 4 *rubles* per lb. already mentioned, raising the total amount of the tax to 0·2521 and 0·2121 respectively for these two classes of diggings. The only exception allowed was in favour of those persons who had commenced boring, and who might continue 3 years longer under the old rates. This increase was apparently justified on the ground that there had been no engagement by the Government to make the 0·15 or strictly speaking the 16·2 tax perpetual. With the lower rate, expectations had been far surpassed, and large private fortunes had been realized. Nothing, therefore, could be said against a higher tax, and the authorities overlooked the twofold consideration that the profit derived from any branch of industry is by no means to be measured by the direct revenue it brings to the treasury, and that this immediate gain seldom grows in proportion with the rate at which it is collected, for soon afterwards they appear to have entertained the proposal to increase still further the duty. Thus, in 1843, the permission was granted to prospect for gold in the Verkneudinsk district of the government of Irkutsk with a new imposition of 0·30 of the value obtained ; and at the same time, in order to control more effectually the industry, a sliding scale of police duties was instituted, to be levied at each individual working, of

5 *rubles* per lb. on diggings which produced from 2 to 5 *puds* of alloyed gold.
7 ,, ,, ,, ,, 5 ,, 10 ,, ,,
8 ,, ,, ,, over 10 ,, ,,

The 4-*ruble* duty was henceforward only leviable at washings where the annual production was under 2 *puds*, and the 4 classes of diggings were then regulated as follows :—

$$\left.\begin{array}{l} 0{\cdot}3121 \\ 0{\cdot}3151 \\ 0{\cdot}3211 \text{ and} \\ 0{\cdot}3241 \end{array}\right\} \text{of the gold obtained.}$$

Not satisfied with this increase, the Government was induced to entertain proposals for acquiring a still larger share in the profits. Two individuals, said to have been Germans holding high rank in the Government service in Siberia, offered to undertake the working of two of the Government washings, returning 50 per cent. to Government. This extraordinarily zealous proposal referred to the Olga and Platonof placers, whose exact position and approximate value were not stated. Apparently it was not accepted; but it led to the elaboration of a scheme introducing important fiscal changes in the administration of the Siberian gold-fields, which was submitted to a commission presided over by the Duke of Leuchtenberg. After 4 years' deliberations, during which a vast amount of material was collected, the principle was adopted of a movable tax, increasing in proportion with the aggregate contents of each individual placer. This was admitted to be most equitable in theory, but in practice the difficulties in the way of applying it were overwhelming. The very large staff of Government inspectors, without whom not even an approximate estimate of the value of the diggings could be formed, and the dissatisfaction it would cause to the proprietors, were disadvantages which far outweighed the benefits of such a system. But since it appeared that the larger diggings, or those which produced most gold, were beyond comparison more profitable than the smaller, it was decided to adjust the taxation in as equitable a manner as possible, keeping in view the interests of the state. Hence, therefore, the principle hitherto adopted was adhered to, the gradations alone were altered, and the scale of duties was raised. From the 14th April, 1849, a measure of the highest importance received the imperial assent; private gold-washings in Western and Eastern Siberia, including Trans-Baikalia, and the Kirghiz steppe, were to be henceforward taxed as follows :—

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[*] 1 lb. of alloyed gold was then worth 330·7 *rubles*.

Annual output.	Principal tax on the gross results.	Police tax per lb. of the result in *rubles* gold.	Total tax on the yield per *n pud* of alloyed gold in silver *rubles*.
1 *pud* to 2 *puds* of alloyed gold.	0·05	4	*n* 826·2
2 ,, 5 ,, ,,	0·10	5	*n* 1528·8
5 ,, 10 ,, ,,	0·15	6	*n* 2231·4
10 ,, 15 ,, ,,	0·17 for the first 10 *puds* 0·25 ,, remainder	7	*n* 3595·4 – 10582·4
15 ,, 20 ,, ,,	0·21 for the first 15 *puds* 0·28 ,, remainder	7	*n* 3992·2 – 13889·1
20 ,, 25 ,, ,,	0·23 for the first 20 *puds* 0·30 ,, remainder	8	*n* 4298·0 – 18519·8
25 ,, 30 ,, ,,	0·25 for the first 25 *puds* 0·32 ,, remainder	8	*n* 4562·6 – 23148·0
30 ,, 40 ,, ,,	0·28 for the first 30 *puds* 0·33 ,, remainder	9	*n* 4736·0 – 19842·0
40 ,, 50 ,, ,,	0·30 for the first 40 *puds* 0·34 ,, remainder	9	*n* 4868·4 – 21164·8
above 50 ,, ,,	0·32 for the first 50 *puds* 0·35 ,, remainder	10	*n* 5041·8 – 19842·0

The result of this impost was still further to increase the revenue of the state from each washing, and almost double it in the case of some of the larger diggings; whilst those which produced less than 1 *pud* of gold paid 300 *rubles*, whether their production amounted to 36 lb. or only 1 lb., and, on the other hand, lessees of Government placers paid besides an additional 0·01, 0·02, 0·03, 0·04, and 0·05 on the value of the gold raised, according to the category they fell under.

The third phase which the Siberian gold-tax entered in 1849 had been in operation but 5 years, when it was found that the industry was seriously diminishing, that many of the placers, from having been originally classed in the highest category, had fallen to those below, and that in fact the Government was killing the goose which laid the golden eggs, instead of merely plucking it. Adjutant-General Annenkof, in his report on his tour of inspection of the Siberian diggings in 1850, called attention to the fact of the constant diminution of profits, caused entirely by the high duties levied. By the end of 1853, most of the diggings were producing a less quantity. It became necessary, therefore, for Government to remodel their fiscal arrangements, if they did not wish altogether to extinguish this industry. Accordingly, in 1854, finance minister Brok introduced a new measure, to be applied in the first instance tentatively for 3 years in the East and West Siberian washings, as well as in the Kirghiz steppe. This was a graduated scale, beginning at 0·05 for those diggings in which the annual production was under 2 *puds*, and rising to 0·20 where the quantity was 10 *puds* and upwards, with a police tax graduated in the same way from 4 *rubles* per lb. to 10 *rubles*, and a slight additional tax of 0·02 and 0·04 payable by lessees of Government workings. Three years' trial of this measure gave most satisfactory results, the production having risen in as marked a degree as it had fallen under the former system; thus the quantity produced in Siberia:—

In 1855	amounted to	1110 *puds*	and the duty	2,745,909	*rubles*.
„ 1856	„	1177 „	„	2,862,168	„
„ 1857	„	1275 „	„	3,152,565	„

Whereas with the higher scale it had fallen:—

In 1851	to 1035 *puds*—	duty levied	3,024,865	*rubles*.
„ 1852	„ 900 „	„ „	2,416,231	„
„ 1853	„ 878 „	„ „	2,377,351	„

A result the more remarkable, because the richest placers were exhausted in 1846–47–48. Indeed 1396 *puds* of gold had been extracted in 1847 out of only 228 million *puds* of ore-stuff, whilst in 1857, 1275 *puds* were washed from 560 million *puds* of ore-stuff. These figures showed that although the sand was 2½ times poorer in 1857 than in 1847, only ⅒ less gold was produced. Amends had now been made for the excessive taxation of former years, but further steps in this direction were considered desirable, in order to develop an industry whose importance was becoming every year more apparent, as a means of rendering convertible the Russian currency, more especially as about this time a dearth set in of the necessaries of life in Siberia, and the price of labour consequently rose. These views were expressed in the law of August 4, 1854, which, while preserving the rates hitherto levied, altered the scale on which they took effect; thus, whereas formerly the owner of a placer which produced upwards of 2 *puds*, though only a fraction over, was liable to pay 0·10 on his whole production, and, in like manner, if he came under the second category, and his production exceeded the limit to the slightest extent, he became amenable to a duty of 0·15 on the whole quantity raised. Mining proprietors were careful not to incur the higher rate of duty by an excess of production beyond the limits imposed by law for the particular category under which they were taxed. To remove this disadvantage, and at the same time to facilitate the working of poorer sands, the finance minister now decided as to the first class of washings to apply the lowest rate to the first two *puds* and the 0·10 only upon any excess up to 3 *puds*, and in the same way in the third class of washings, to charge the 0·10 duty on the first 5 *puds*, and the maximum rate of 0·15 only on the surplus. The rise to 0·20 and the 10-*ruble* poundage were altogether abolished, as were also the additional 0·02 and 0·04 on the yield of Government placers worked by private persons.

The so-called Siberian committee upheld the view that the reduction of the duty had restored the gold-industry to its former compass, for on the 14th April, 1858, they passed the fifth gold-tax based on the foregoing. According to this, private gold-washings in Western and Eastern Siberia, the outskirts of Semipalatinsk, and the Kirghiz steppe, had to pay:—

On an annual production of	Principal tax on gross production.	Police tax per lb. of extracted gold in *rubles* gold.	Total amount of duty on *n pud* of gold in *rubles* silver.
$\frac{1}{3840}$ to 2 *puds*	0·05	4	*n* 826·2
2 ,, 5 ,,	0·5 for the first 2 *puds* 0·10 for anything above	6	*n* 1569·9 - 1322·8
over 5 ,,	0·10 for the first 5 *puds* 0·15 for the remainder	8	*n* 2313·8 - 3307·0

These rates applied to all washings leased from the Government in Siberia and in the Ural, as well as in the government of Orenburg and the Cossack lands. In Bashkir territory, the maximum duty was fixed at 0·10 whether or no the production exceeded 5 *puds*; whilst in the Verkneudinsk gold-field, part of the principal tax belonged to the cabinet of

H.I.M., or, as we should say, to the privy purse. The only exception was in the Caucasus and in Trans-Caucasia, where the tax of 1854 remained in force.

Summarizing, then, the whole period during which the gold-industry has existed in Russia, from 1812 to 1874, Bogoliubsky estimates that ⅕ of the gold raised belonged to the state and ⅘ to individuals, who paid about 100 million *rubles* on all the gold obtained, so that 32 per cent. of the production fell to the share of the Government.

When private enterprise was first admitted, in 1812, a 10-per cent. tax was imposed. In 1838, a graduated scale of 10 different rates, ranging from 5 to 35 per cent., according to the yield of gold, was instituted. This was found too onerous by the miners, and was replaced in 1854 by another which divided the diggings for the purposes of taxation into 4 classes with rates varying from 5 to 20 per cent. on the whole quantity raised. But even this was found excessive, so exhausted had the workings become; and in 1870, a 3-rate tax of 5, 10, and 15 per cent. was confirmed, and this was finally modified in 1876, in order to encourage the industry, which had begun to show symptoms of decline.

From the commencement of the gold-industry to 1860, 893 persons were concerned in the management of washings, of whom, 478 belonged to the class of hereditary and personal nobility, 415 to the mercantile and hereditary honorary burgher class. These persons superintended the working of 2202 placers, of which :—

703	were in E. Siberia.
485	,, W. ,,
241	,, Kirghiz territory.
313	,, the government of Orenburg.
255	,, ,, ,, Perm.
205	,, the governments of Great Russia.

In 1860, the number of existing placers was increased by 883, situate as follows :—

167	in E. Siberia.
19	,, W. ,,
3	,, Kirghiz lands.
3	,, estates of Ural iron-works.
63	,, lands of Cossacks and Teptiars in the government of Orenburg.
628	,, private and Government lands in the government of Perm.

The striking increase in the government of Perm is explained by the circumstance that the Crown lands in the Verkhoturiye and other districts were then first made accessible to private enterprise, and numbers of gold-seekers were attracted thither by reports of rich finds.

In 1860, the maximum yield of any single placer was again, as in former years, in the Northern Yenisei gold-field, at the Gavrilof washing of the merchant Rézanof, which produced in that year 102·575 *puds* (3692·7 lb.) of alloyed gold, or 3·5 *puds* more than the maximum attained in 1842 at the Spassky placer of the merchant Miasnikof, on a tributary of the Uderey, which had not been exceeded for a long time. The following table shows the annual production of all the Russian gold-washings, and the amount of duty levied from them.

Year.	Alloyed gold obtained in Russia from		Total.	Duty levied from private works in silver *rubles*.
	Government works.	Private works.		
	puds.	*puds.*	*puds.*	
1814	16·0866	..	16·0866	..
1815	14·2263	..	14·2263	..
1816	15·7963	..	15·7963	..
1817	18·1761	..	18·1761	..
1818	16·6627	..	16·6627	..
1819	13·7989	0·4284	14·2273	709
1820	18·3933	1·2255	19·6188	2,027
1821	20·4643	7·2406	27·7049	11,975
1822	25·0543	28·7489	53·8032	47,548
1823	36·4159	69·2514	105·6673	136,716
1824	53·4368	152·3963	205·8331	252,331
1825	65·7386	171·6895	237·4281	333,462
1826	69·6834	161·5761	231·2595	317,240
1827	89·5678	192·2627	281·8305	379,031
1828	87·4466	203·4048	290·8514	400,709
1829	100·9103	188·7803	289·6906	369,578
1830	151·1973	209·0012	360·1985	404,779
1831	161·8293	206·0170	367·8463	396,234
1832	170·3090	216·1142	386·4232	417,168
1833	148·3428	230·3427	378·6855	442,513
1834	150·2298	224·9109	375·1407	446,269
1835	153·1193	233·0855	386·2048	465,753
1836	150·0558	248·7066	398·7617	498,625
1837	157·0579	285·5032	442·5611	586,212
1838	160·0909	333·0386	493·1295	679,767
1839	166·3836	329·4245	495·8081	666,625
1840	167·9110	390·0750	557·9860	798,679
1841	160·7742	485·6243	646·3985	1,009,764
1842	171·6151	737·4615	909·0766	1,570,527
1843	177·8643	1063·4286	1241·2929	2,488,642
1844	184·4787	1095·4430	1279·9217	2,562,753
1845	176·6189	1130·5817	1307·2006	2,644,614
1846	187·6133	1424·0489	1611·6622	3,468,749
1847	188·8633	1568·3365	1757·1998	3,919,161
1848	195·1617	1489·5546	1684·7163	3,674,667
1849	193·7409	1394·3861	1588·1270	4,836,275
1850	241·1302	1212·6807	1453·8109	3,603,388
1851	234·7118	1239·3585	1474·0703	3,413,243
1852	244·7853	1121·9764	1366·7617	2,845,370
1853	267·2554	1096·1559	1363·4113	2,815,994
1854	306·2966	1290·3738	1596·6704	3,227,088
1855	264·8303	1384·5136	1649·3439	3,283,528
1856	241·2873	1414·1980	1655·4853	3,210,802
1857	236·0542	1497·5423	1733·5965	3,472,513
1858	248·3876	1439·2186	1687·6062	2,489,986
1859	210·7042	1331·1405	1541·8447	2,283,385
1860	214·4992	1242·9005	1457·3997	2,043,270
in 47 years	6745·0567	28742·1479	35487·2046	66,917,669

Note.—The *pud* may be taken at 36 lb., the *ruble* at 2s. 6d.

The considerable differences between these figures and those issued by the minister of finance cannot be explained. A comparison of the amount of duty received with the value of the metal raised will illustrate the effects of the consecutive systems of duty adopted on the gold-industry, and the direct results to the imperial treasury. The total production is derived from three chief sources of production,—Siberia, the Ural, the Orenburg and Perm private gold-washings. The two kinds of duty levied, viz. that in kind, or by the weight of the gold produced, and the police tax paid in coin, are added together in the fifth column, the values being reduced to silver *rubles*. The quotients for the successive years given in the fifth column of the table are derived from the numbers in the third column, taking the average profit by the state from the alloyed gold obtained at private works.

It appears then that 1 *pud* (36 lb.) of alloyed gold brought the state on an average—

In 1820	..	1654 *rubles* (value about 2*s.* 6*d.* each).
1830	..	1942 ,,
1835	..	1936 ,,
1840	..	1998 ,,
1845	..	1626 ,,
1850	..	2339 ,,
1855	..	2971 ,,
1858	..	1730 ,,
1860	..	1644 ,,

The impost on the private gold-industry therefore in the 3 years 1858–59–60 returned nearly to the very moderate value it represented at first, the decline in the production for these 3 years, as seen in the third column, being attributed to the increasing dearness of the necessaries of life and labour in Siberia. But the gold-mining industry had as yet attained a very low development, for during 1860, the works in Siberia were entirely without steam machinery, whilst in the Ural private washings, only 4 steam-engines were in use. All works owned by private individuals for that year employed :—

	Men.	Women.	Horses and oxen.	Steam-engines.
In W. and E. Siberia	31,796	919	8,751	0
,, the Ural	20,352	2181	8,339	4
Total	52,148	3100	17,090	4

The following summary of statistics is taken from a translation by Koopman (published in the *Mining Record*) of Koppen's review of the 'Mining Industry in Russia from 1860 to 1877.'

"Gold production in Russia was started by the Government in 1745. In that year the first gold and silver were obtained on the Schlangenberg in the Altai, and sent to St. Petersburg. In the same year, 1745, gold was also first found in the Woitzkisch mine (govt. Archangel). The year 1745 was finally made remarkable in the history of Russian mining by a third discovery which laid the foundation for all the later gold wealth of Russia. This was the discovery of the gold mine of Beriosofsk in the neighbourhood of Ekaterinburg, which sent its first gold to St. Petersburg in 1745, namely: 16 lb. 59 *zolotniks* and 54 *doilias* of bullion.

"The most important effect upon the gold production was wrought by the abandonment of the Ukas, May 28, 1812, in consequence of which private citizens were permitted to take up gold and silver mining on their own account. The working of the gold-washings, or the so-called gold-dust, was first granted to citizens in the year 1819, and then only to the owners of mining or smelting works. Newjansk on the Ural is where the first gold was washed by private enterprise, and until the year 1828, private gold production confined itself to the district of the Ural mountain range. Later, gold production began to extend generally, reaching further and further eastward into Siberia, and now gold is obtained in all West and East Siberia, in the governments of Perm and Orenburg, and in the Kurghiz steppes. There the Government until very lately, had gold-washings on the Ural; the Government of his majesty the Tsar now works the gold in the Altai and Nerchinsk mountain district, and, finally, private citizens in all the above-mentioned regions are engaged in gold production.

"From the crown and private washings was obtained in 1814–1859, in gold alloy :—

Years.		pud.	lb.	Years.		pud.	lb.	Years.		pud.	lb.
1814	..	16	3½	1830	..	360	8	1845	..	1611	28½
1815	..	14	9	1831	..	367	33¾	1846	..	1757	8
1816	..	15	32	1832	..	378	27½	1847	..	1684	28¾
1817	..	18	7	1833	..	375	5½	1848	..	1588	5
1818	..	16	26½	1834	..	386	8¼	1849	..	1453	32½
1819	..	14	9	1835	..	398	30½	1850	..	1474	2¾
1820	..	19	24¾	1836	..	442	22¼	1851	..	1366	30½
1821	..	27	28½	1837	..	493	5	1852	..	1363	16½
1822	..	53	32	1838	..	495	32¼	1853	..	1596	26¾
1823	..	105	26½	1839	..	557	39½	1854	..	1649	13¾
1824	..	205	33½	1840	..	646	16	1855	..	1655	19½
1825	..	237	17	1841	..	909	3	1856	..	1733	23¾
1826	..	231	10	1842	..	1241	11¾	1857	..	1687	24
1827	..	281	33¼	1843	..	1279	26¾	1858	..	1541	33¾
1828	..	290	34	1844	..	1307	8	1859	..	..	..
1829	..	289	27¼								

"Since the year 1860, which I have taken for the beginning of my review, there has been obtained in gold-dust from the washings belonging to the crown, to the cabinet of his majesty the Tsar, and to citizens :—

Years.		pud.	lb.	Years.		pud.	lb.	Years.		pud.	lb.
1860	..	1491	17½	1866	..	1659	19¼	1872	..	2308	12
1861	..	1456	4½	1867	..	1649	24½	1873	..	2024	38½
1862	..	1460	29	1868	..	1711	16½	1874	..	2028	4½
1863	..	1459	19	1869	..	2028	31½	1875	..	1995	29½
1864	..	1397	37	1870	..	2162	27½	1876	..	2094	3½
1865	..	1576	7¾	1871	..	2400	36¾	1877	..	2502	6½

"From the above figures it may be seen that before 1860, the output of gold was the richest in the years 1847 and 1857, amounting to more than 1700 *puds*.

"From the year 1857 began a falling off in the gold yield, which amounted in 1860 to only 1491 *puds*, and in 1864 even fell below 1400 *puds*. In the seven years following, gold production made a swift advance and rose almost 1000 *puds*; in the next four years it sank again to below 2000 *puds*, and not till the last two years, 1876 and 1877, was a rapid rise again noticeable, when the height of 2500 *puds* was reached.

"Scanning the above tables more closely, we note at once that the recorded shrinkage in the total gold yield of Russia, depended altogether upon the output of private washings. The fall in gold production at that time was chiefly due to weather-conditions; that is, either to drought which caused a lack of water at the washings, or to excessive rain, in consequence of which the rivers overflowed, preventing a rich yield from the gold-bearing sands; and finally, not seldom, both these obstructions falling in the course of a summer, first drought and then continued rain, brought work at the gold-washings to a standstill. Moreover, the following must be accepted as causes which influenced the lessening of the gold yield; the utter exhaustion, not only of separate rich washings but also of the whole district, and the failure of many owners.

"Temporary rises in the gold yield were brought about by chance discoveries of exceedingly rich gold-diggings. The sudden rise in figure of the gold-dust obtained in the last two years depends partly upon the increa the percentage of gold duty, established in 1876, though chiefly the high value of our coin, since as is known, for all gold delivered at the mint, account was made in half imperials, these being reckoned at their face value.

"According to districts, the gold obtained in Russia is divided as follows:—

GOLD YIELD IN RUSSIA (IN *puds*.)

Year.	Ural.		West Siberia.		East Siberia.		Finland private.	Total.
	Crown washings.	Private washings.	Altai Mt. district.	Private washings.	Nerchinsk Mt. district.	Private washings.		
1860	114¾	214½	33¼	38½	75¾	1014¾	..	1491½
1862	96¾	196½	20	42¼	83¾	1021¼	..	1460¾
1867	91¼	302½	23¾	86¾	142¼	1003¼	..	1649½
1872	129¾	283	13½	176	153¼	1519¼	3¼	2308¼
1877	13	392½	11¾	130½	142¾	1811	½	2502

"From this table it may be seen that:—

1. At the crown washings on the Ural, the gold production had well-

nigh stopped. In the year 1876, only 63 *puds* of gold were obtained here, and in the year after barely 13 *puds*. This sudden change arose from the fact that in the year 1876, the crown washings of Miask were given over to private citizens.

2. The figures of the gold yield at the Ural private washings, which made 286 *puds* in 1876, rise at once in 1877 to 392½ *puds*, through the addition of the yield from the washings of Miask.

3. In the Altai district the gold product shows a continual falling off, and hardly amounts to 12 *puds* in 1877, that is, it has become reduced to one-third in the last eighteen years.

4. Quite the contrary do we find in the gold-washings of citizens in West Siberia, where the gold yield slowly but steadily rises, and has increased three and a half times in the course of eighteen years.

5. In the Nerchinsk mountain district, the gold yield doubled from 1860 to 1872, and in the last year amounted to 153 *puds*. Since 1872 it has again fallen a little.

6. The private washings of East Siberia furnish the greatest amount of gold, and entirely govern the rise in the total gold yield of Russia. While, in the last eighteen years, the washings worked by private citizens in East Siberia have increased their production by about 800 *puds*; all the remaining gold-washings were only in a condition to raise their output of gold to 200 *puds*. From 1860 to 1877, the gold yield of the private washings in East Siberia, increased about 80 per cent.

7. Finally, it is to be noticed that gold production began in Finland in 1870, and reached its highest point in the year following, when the figures of the gold here obtained made only 3 *puds* 18 lb. From the year 1872, the gold yield of Finland gradually sinks, and in 1877 comes to less than 20 lb.

"If we consider the year 1877, we see that the percentage of gold yield is shared by the different districts, as follows:—The private washings of East Siberia furnished 72·4 per cent. of the total yield; the private washings of the Ural 15·66 per cent.; the Nerchinsk mountain district 5·7 per cent.; the private washings of West Siberia 5·2 per cent.; the Ural crown washings 0·52 per cent., and finally the Altai mountain district 0·43 per cent.

"As the private washings of East Siberia furnish at most three-quarters of all the gold obtained in Russia, we give in the table on page 442 a statement of the yield in the different districts of that Territory.

"In the district of Yeniseisk, which was once distinguished for its gold wealth, the yield began to lessen in the 50's, and from 1860 to 1877 it diminished during the whole period. Especially strong is this falling off in the northern part of the district, which furnished in 1860, 425 *puds*, about 42 per cent. of all the gold obtained in the whole of East Siberia. In the year 1877, only 158½ *puds* were obtained here, that is, not more than 8·75 per cent. of the total gold yield of East Siberia.

GOLD YIELD IN EAST SIBERIA (IN *puds*).

Year.	Government of Yeniseisk.					Transbaikal.				Olekminsk district (Government Yakutsk).	Amur territory.	Coast region.
	Yeniseisk district.		Atchinsk district.	Minusinsk district.	Kansk and Nijneudinsk district (Government Irkutsk).	Verkneudinsk district.	Barguzinsk district.	Nerchinsk district.	Vercko-Lensk district.			
	Northern part.	Southern part.										
1860	425¼	188¾	20	48¾	31¼	15½	85½	..	..	199½	..	..
1862	376½	181¾	15	49½	29½	16	131¾	..	..	217	.	..
1867	324¾	119	21	31¾	26½	13	94¼	105¾	..	267	..	..
1872	246½	162¾	15¾	29½	12¾	12½	60½	177	1	630¾	196	4½
1877	158½	167¼	20	37¼	37¾	13¼	27¼	227¾	..	928	172	12¾

"In the other districts belonging to the basin of the Yenisei, such as Atchinsk, Minusinsk and Kansk in the government of Yeniseisk, and Nijneudinsk in the government of Irkutsk, the mass of gold produced is in the main not large, and has suffered no special change during the last eighteen years.

"As concerns the Transbaikal, it is plain that in the district of Verkneudinsk and Barguzinsk, the gold yield continually diminishes. In the latter of these two districts, the total gold product amounted in 1877 to not more than 27¼ *puds*, which is about one-fifth of that yielded in the year 1862 (131¾ *puds*).

"In the district of Nerchinsk, private citizens were first permitted to work the gold-washings in the year 1864, and here in 1865, began a gold yield (32 *puds*), which, very swiftly rising, reached the sum of 227¾ *puds* in the year 1877, that is, increased sevenfold in twelve years.

"In the district of Vercko-Lensk, gold production has been in operation since the year 1867, and in extremely narrow compass, goes on without interruption.

"Undeniably, the richest and most productive gold-washings are found in the basin of the Lena and its tributaries, the Vitim and the Olekma in the Olekminsk district, in the government of Yakutsk. In the year 1860, the amount of gold produced in this district came to less than 200 *puds*; in 1877, 928 *puds* were obtained here, that is the yield increased more than four and a half times.

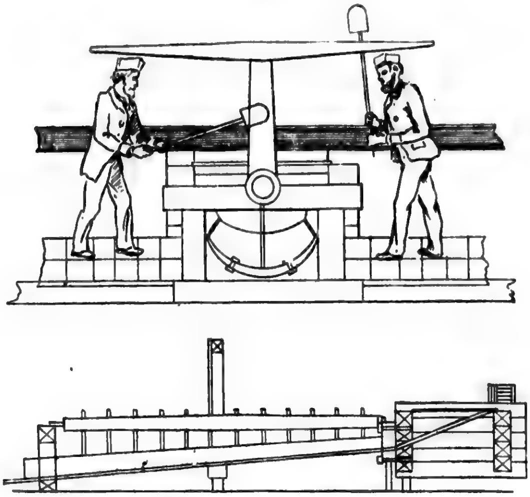
"In the Amur district, gold production was granted to citizens in the year 1866, but the yield began in 1868 with a sum of 50 *puds*. In the next year (1869), the yield is doubled, and from that rises generally, and in the year 1872, reaches the figure of 196 *puds*. In the years following, the yield suffers but little shrinkage and varies between 150 *puds* (1874) and 173 *puds* (1875).

"In the coast region of East Siberia, gold production began in 1872, continues with interruption, and makes but slow development, which must be ascribed to the lack of skilled labour and the dearth of necessities.

"Finally, it must be observed, that in the year 1877, gold production began again in the districts of Krasnoyarsk and Irkutsk, in the government of Yeniseisk, 8 *puds* 24 lb. of gold being yielded by the former, and 7 lb. by the latter."

Apparatus employed on Russian Gold-fields.—The apparatus employed by the Siberian gold-seekers for washing auriferous sands is of several forms. In operating that shown in Fig. 14, described by Warington Smyth, 8 or 10 men may be employed. The sieve or grating, firmly fixed, is 3½ ft. sq. The tye, into which the fine sand is carried by an inclined plane, is 16 ft. long × 2½ ft. wide, with an inclination varying according to the more or less loose nature of the sand, from 24 in. to 16 in., and having its bottom curved in the arc of a circle. Above the tye, and placed in the direction of its length, is a wooden axis turning in

FIG. 14.

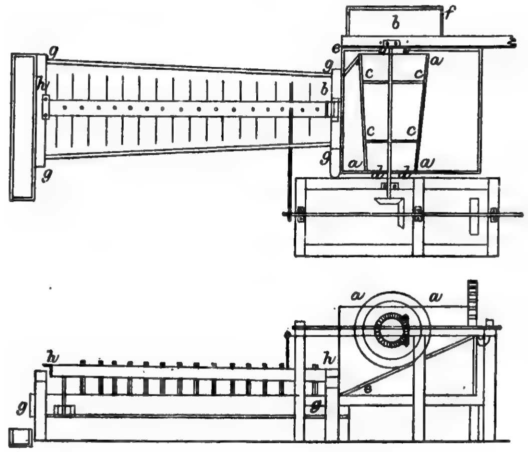


RUSSIAN GOLD-WASHING APPARATUS.

gudgeons, and having fixed to it on the under side as many arms as the tye has compartments, each of which arms is fitted with a number of claws or blunt knives; and by an alternating motion given to the axis by 2 men holding a line attached to it, the claws pass backward and forward in an arc, and keep the sediment in continual agitation. The partitions in the bottom are ribs 2 in. high and 2½ in. wide, held by screw-bolts and nuts; and are removed every now and then for washing out the concentrated auriferous sand, the more frequently as the sands are the richer in gold.

Agté's machine, used at Alexandrof, is shown in Fig. 15: *a*, truncated cone of perforated sheet iron, fixed by an iron frame *c* to horizontal axis *b*, which is made to revolve by a water-wheel about 30 times in a minute; *d*, opening at which the cylinder is charged; *i*, opening at which large pebbles roll out over the board *f*; *e*, inclined plane by which the sand that passes through the sieve is carried down to the tye or long trough *g*, the plan of which is a truncated cone, and whose bottom is concave; *h*, axis above the tye, to which are affixed arms carrying iron knives to stir the sediment, and making 20 to 25 oscillations per minute.

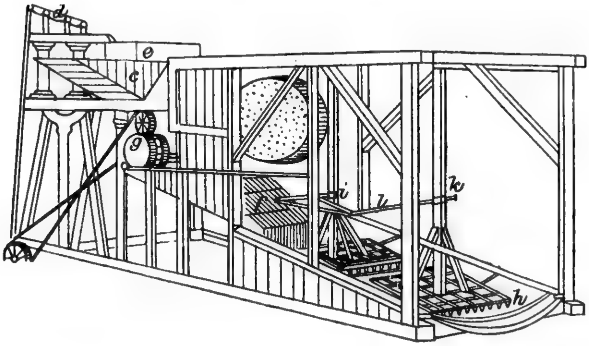
FIG. 15.



AGTÉ'S GOLD-WASHING APPARATUS.

Phillips describes a similar machine for horse-power, used in the Urals, and shown in Fig. 16: *a*, sheet-iron cylinder pierced with ½-in. holes, and strengthened on the inside by an iron trellis. The cone, which may be about 8 ft. in length, and has a mean diameter of 3 ft. 6 in., is larger at one extremity than at the other, and is fixed on a spindle capable of being set in rapid motion by means of a train of wheels worked by a horse-whim. The auriferous sands are brought in waggons running on iron rails to the hopper *c*, whence they fall into the movable cylinder through the aperture formed by its smaller circumference. At the back of the arrangement is a double pump *d*, set in motion by a crank on the shaft, which communicates motion from the whim to the cylinder *a*. This pump raises water into the cistern *e*, whence it is conducted by 4 iron pipes into the cylinder *a*. These pipes enter the cavity of the drum through the two open ends, and are so arranged with regard to length as to afford a nearly equal supply of water throughout its whole capacity. When set in motion, the perforated cylinder makes 30 to 35 revolutions a minute, and consequently throws, by its centrifugal action, the water and finer particles of sand and gravel through the numerous perforations which it contains; whilst the pebbles and other fragments which are too large to pass through the holes, are carried off through the larger end of the cylinder, and then fall into a box (not shown). This receptacle will contain any nuggets which may have been present in the sands; and as, by passing through the cylinder, they will have been washed perfectly clean, they may now be readily seen and picked out. The sand and water after having escaped through the apertures in the drum, fall on the inclined platform *f*, which is provided with numerous horizontal bars, for the purpose of separating the heavier from the lighter portions. From this platform, the current flows on to the concave table *h*, also provided with checks, in the form of wooden bars nailed across at distances of about 3 ft. from each other. The sands which have arrived at this part

FIG. 16.



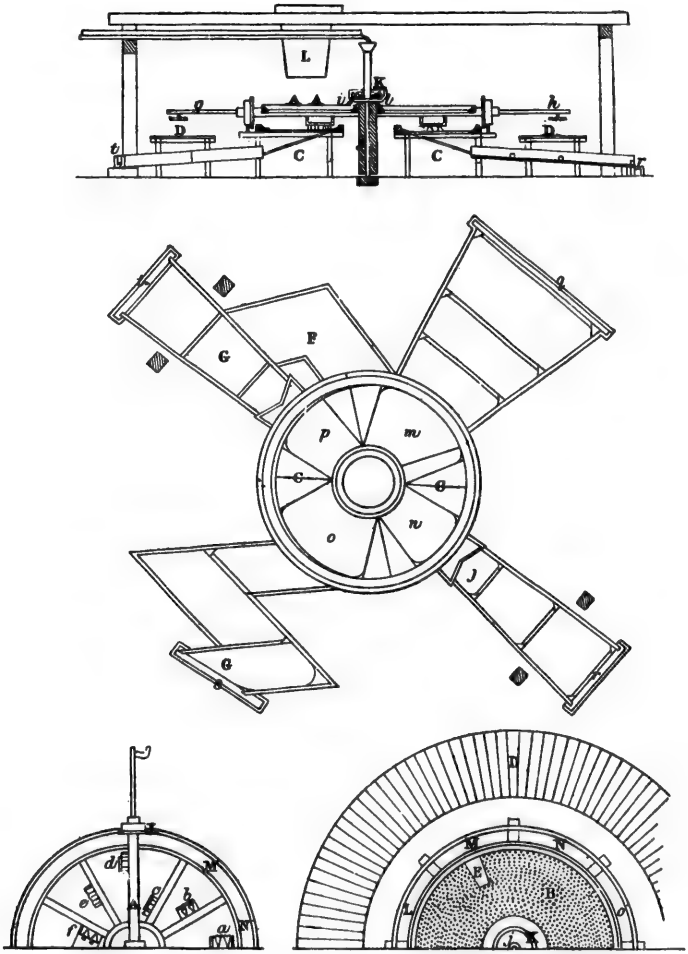
URAL GOLD-WASHING APPARATUS.

of the table are now kept constantly agitated by the wooden pendulums *i k*, provided at their lower extremities with frames made to suit the concavity of the table, and fitted with flattened teeth, like those used in harrows. These pendulums are made to swing by means of the rods *l*, driven by the crank *g*, and are so arranged as to move constantly in opposite directions. In this way the operation is continued, until a considerable accumulation of rich auriferous sand has taken place in the upper part of the tables, where, being retained by the horizontal slips of wood, it remains; whilst the lighter matters are carried off by the current of water to the lower end of the table *h*, whence they are either made to pass over a fresh series of tables, or if, as usually is the case, they are found to be sufficiently impoverished, they are allowed to run entirely away.

Another apparatus, described by Capt. Razguildeyew, is shown in Fig. 17. Its description is as follows:—A, upper ring, across which are suspended the iron harrows *a b c d e f*; it performs a rotatory motion by means of the two lever arms *g h*, on the tramway L M N O. B, grinding floor or sieve; it is a little concave in the centre, and is formed of plates of cast iron joined together: for greater lightness, it might perhaps be made of wood covered with sheet iron. C, lower stage of the apparatus, on which the disintegrated sand can fall from the sieve; then the sand, borne by water, falls on the washing-tables *m n o p*, which effect the concentration of the auriferous matters. *q r s t* are reservoirs, for the dirty water and sand. From these reservoirs the sands are either (according to their assay) finally thrown away, or re-washed on a table. D, horsewalk. E, opening for exit of pebbles and gravel. F, auxiliary table for final washing pebbles. It is placed under the sieve to avoid transport; they should fall of themselves upon the table, and there be carefully washed. The dirty water from this table passes over another one adjacent G, on which finally the minutest particles of gold are deposited. K, general receptacle or box of cast iron fixed to the iron spindle *j*. The water from this reservoir is spread by the iron pipes *i l* arranged so as to wet the sands. This same water passes over the washing-tables and thence into the settling-reservoirs. L, sludge-channel for the sands. The apparatus employs 6 horses and washes 10,000 to 12,000 *puds* (of 36 lb.) per 24 hours.

Tatarinoff gives the following description of the washing operations, as conducted throughout Central Asia. A framework of light willow poles, with a convexity of about 35° to the horizontal plane, takes the place of the usual washing-box. Upon this framework, firmly fixed in the ground, is stretched a blanket or carpet to catch the auriferous alluvium. In order to retain the gold, which has of course a greater specific weight, thick horsehair ropes are sewn along the whole length of the blanket. The frame being now ready, a bag-full of ore-stuff is emptied into it; water is then poured on and stirred with a small stick, whilst stones are flung aside.

FIG. 17.



RUSSIAN GOLD-WASHING APPARATUS.

When 3 to 4 cwt. of alluvial soil have been treated in this way, the men proceed to collect the sediment adhering to the blanket. For this purpose, the blanket is taken off the frame, folded in several thicknesses, and subjected to another washing in the following way:—A wooden bowl or trough, large enough to contain the folded blanket, is placed in a small bay of the river where the current is slack. The workman then removes the blanket, fold by fold, and washes it, allowing the sediment to collect at the bottom of the trough. Having accomplished this, he takes the bowl in his hands, and moves it rapidly with sudden jerks to right and left, splashing the water and the lighter soil over the sides. From time to time more water is added, and the work is continued for several hours without intermission. As the gold in the bowl gradually detaches itself from the particles of sand mixed with it, the movements of the workman become more and more artistic and careful, his whole object being to leave nothing but pure gold, however small the quantity, in his bowl. When this has been obtained, he dips a finger into the water, and flicks a drop or two into the bowl, pouring them out together with the gold into a separate porcelain cup. This finishes his day's work.

The process at Beriozofsk, in the Ural, as seen by the writer, is carried on in a circular wooden frame or box, some 10 ft. in diameter, with a perforated iron bottom, and open at the top, and in which revolves a heavy 4-handled iron rake, driven by steam-power. Into this box, barrow-loads of ore-stuff from the mine are continually emptied. The clay or sand mixed with water is sifted in this way, the lighter particles being carried away, the heavier dropping through the metal sieve. After a second washing, the gold is finally separated from any remaining adherent particles of soil by hand. For this purpose, skilful and experienced workmen stand on a flight of broad wooden steps, over which flows a thin stream of water, clear as crystal. After manipulating the auriferous sand for a long time, the workman at last produces an insignificant quantity of fine gold-dust in the palm of his hand. In this way, 10,000 *puds* (about 160 tons) of ore-stuff daily pass through the Beriozofsk works. So imperfect, however, is the process, that the director stated that a second or even a third washing, an interval of 2 or 3 years having elapsed, yielded better results than the first.* The percentage of gold at Beriozofsk in 1861 was very small—only 30 gr. in 100 *puds*—whilst in former years as much as 2 and 2½ *zolotniks* (131½ to 164½ gr.) had been obtained. Across the frame, branches or sticks are set at close intervals; the whole apparatus stands 4 ft. 6 in. high by 1 ft. 2 in. wide.

The American method of gold-washing, and its adaptation in the Yenisei gold-fields.†—The American or Pakulef system of working and washing gold consists in throwing the auriferous soil into long wooden troughs or boxes ("sluices"), averaging 12½ ft. long, inclined upon wooden frames, and joined one to the other. Into these a powerful stream of water is admitted, which washes the shingle or peat, carrying off the earthy parts and small pebbles into a trench or wooden well placed below. The gold should sink to the bottom, and be retained there by perforated wooden boards, while the larger stones are thrown aside by workmen with iron forks or rakes. The only difference between peat and detritus washing is that in the latter case one end of the vat rests on the shingly wall of the placer, and water is laid on by troughs; whereas in removing the peat, the boxes are immediately below it, and water is supplied from a trench.

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* This fact implies, perhaps, not so much imperfection in the process, as the presence of pyrites, which, being oxidized by the exposure during a considerable length of time, gave up the gold on further treatment.

† This section should be read in connection with Chapters III., IV., and V.

This mode of washing is very general in America and Australia, and though Pakulef, its introducer into Siberia, claims to have been its originator in California, and describes it, there are grounds for believing that it existed in America before his time. As long ago as 1850, alluvium was washed in California in rockers, long-toms, and sluices, and the last were nothing more than wooden troughs or boxes fixed on a slope, and paved with stones, fastened to the bottom by laths and planks. Pakulef probably saw them at work, and successfully adapted them in his vats or boxes, substituting woodwork or riffles for the stone pavement.*

The first adaptation of this method to Siberian diggings was made by Lavrofsky, in 1858, at a claim located by Zotof, of which he was manager, and the trial then made was apparently so successful that it raised hopes and expectations impossible to realize, and led to a warm controversy between the innovators and conservatives. It was finally decided to have a grand trial of the American method, in order to set the vexed question at rest. Works were accordingly arranged by Lavrofsky at three large placers of the Zotofs, where 1800 men were employed. After a year, the results were counted up, and showed a great diminution in the quantity of gold as compared with the average yield of former years. Lavrofsky obtained only 67 *puds* (2412 lb.), instead of the usual 100 *puds* (3600 lb.) to 120 *puds* (4320 lb.). This fatal blow to the innovators was due to over-confidence on their part, and a neglect to take local circumstances into consideration. They had only themselves to blame. Latkin, who was present at these trials, attributed their failure to the unfavourable character of the alluvium, the inexperience of the men, who were moreover too numerous, and their careless, ignorant way of setting about their work. One serious mistake was in attempting too much, by washing the detritus and removing the peat with the same apparatus. But whatever the errors, after repeated unsatisfactory trials, the thing fell into disrepute, and was thought badly of. Latkin, however, achieved a complete success in experimenting on waste heaps of sand at his Uspensky mine on the Kuntuyakicha; here the American system was undeniably good, and at other placers, notably those of Golubkof's heirs, equally good results were obtained. At the same time, an adaptation of it at the Uspensky placer to part of the work only, viz. washing alluvium, was successful, and a brilliant future was predicted for it, particularly when much-needed reforms in legislation had been carried out, and the gold-industry was thrown open to the multitude instead of being reserved for the privileged few. The history of Latkin's trials with the American system, or *amerikanka*, as it soon came to be known among miners, is that of the invention itself in Siberia. From 1860 to 1866, he alone used it, and, as a still further proof of its success, it may be mentioned that during this period the annual sum paid to Lavrofsky for the right of working with it amounted in the aggregate to 12,000 *rubles* (1500*l.*). The general conclusion arrived at by Latkin was that the American system was advantageous wherever the fall or slope was sufficiently steep, and the detritus not too compact or stony; that the loss or waste in gold was trifling, notwithstanding all that had been said to the contrary; and that its defects were such as were common to all systems of gold washing. Good supervision by trustworthy and well-paid overseers is of course as indispensable as it is with the buddles; but even with the strictest watch, it is as impossible to put a stop to gold-stealing as it is to every other kind of theft.

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* In Baron Richthofen's work on the metal productions of California there is not the slightest allusion to a Russian invention or to the Russian riffles mentioned by Pakulef in his pamphlet, and claimed as his own invention, though doubtless so important a method of washing gold, and one in such general use, would not have escaped the notice of so good an observer, had it been in existence at the time, and had Pakulef been recognized as its inventor.

Latkin's first trials of the American method were completely successful, partly no doubt owing to the looseness of the débris, and partly because sufficient gravel was ready for washing; the peat had not to be removed, the incline was sufficiently steep, and there were not too many hands in the works. As soon as success was assured, a second apparatus was put up, and then the noise and creaking of the barrel-machines ceased, and the cost of labour was reduced by one half. Next an attempt was made on the peat. Even this was successful; a cubic fathom of it could be removed for the cost of a labourer's wage for 1½ day without horses. But it should be mentioned that the peat in this instance was exceptionally light, and free from stones and boulders; had it been otherwise, the cost would have been 2 days' labour, or even a little more. Upon the whole, experience proved that the best plan was to keep the two operations distinct, and to wash the auriferous soil with the *amerikanka*, removing the overlying peat with carts and wheelbarrows.

The following years, 1860–61, proved still more the profitableness of the American method, as applied in the Siberian gold-fields, for these were years of scarcity and high prices, both for man and beast. At one placer alone, the saving in forage in 1862 amounted to 6500 *rubles* (800*l.*), and the cost of each individual labourer fell to 267 *rubles* (33*l.*), inclusive of the payment of 10 *rubles* (25*s.*) per man to Lavrofsky as royalty for the right of using his patent. In 1861 and 1862, Latkin successfully worked four diggings on the American system, with good results, though at one the alluvium was very strong, and contained a compact kind of clay in its upper strata; at another, slates with adhering portions of clay caused some difficulty. At these two placers it was found expedient to supplement the *amerikanka* with buddles. Any portions that remained unwashed passed into the buddles, and were there subjected to a second sifting. But the detritus soon became more friable at one digging, and buddles were dispensed with; at the other, they were continued throughout the summer. Buddle washing is a simple arrangement. The usual buddle contains 3 rows of vats, and is therefore 6 to 7 ft. wide, so as to contain stony detritus which would not find room in those of ordinary dimensions (21 in.). The length of the buddling-box containing the iron sieves is also 6 to 7 ft., and the inclined platform which receives the auriferous sediment after it has dropped through the holes in the sieve is about 12 ft. long, with a breadth corresponding to that of the box, and a slope of 1 in 4 or 1 in 5. The buddle can be moved on wooden rollers, or even without them, to any part of the digging. To one of these, two or at most three lengths of troughs are fastened, the lower end opening into the side of the buddling-box, so that the whole of the detritus to be washed with the stones and water slides straight on to the sieve, where it is finally sifted by the rakes of the workmen, and disintegrated. The shingle is then pushed to either side of the box down wooden hatchways, through which it falls on to the waste heaps, whilst the gold sediment and water pass through the sieves to the sluice or inclined platform, on which are wooden laths or a framework or grooves to catch the gold. The sediment is then carried down the incline by the stream to a wooden well at its foot, whence it filters away into the tail-race, at which stand workmen with spades to throw it up on either side. The shingle, if there should be much, is removed in barrows; but if little, it remains on the surface.

When the detritus is hard or compact, separate workmen stand on either side of the American troughs with forks or rakes, to follow the sand and shingle to the buddling-box. It is remarkable that by the time the detritus, however hard, reaches the buddle, it has parted with most of its gold, which remains in the troughs under the wooden riffles, and only 25 per cent. in extremely difficult alluvium, or 20 per cent. on the average, is collected on the buddling-platform. Of course, where the detritus is loose or gravelly, all the gold remains in the first or second trough, very little, if any, in the third; and, when there are four lengths, or, as occasionally happens, five or six, placed in irregular lines, the last contain absolutely no gold. This is the best proof of the small waste with the American troughs. Latkin's experiments on waste heaps of sands which had passed through the *amerikanka* resulted in an infinitesimal quantity of gold,—less than 30 *doilias* (20 gr.) in 240 tons of sand, a little more than this in the shingle, but the average waste may be set down as not more than 2 *doilias* (1½ gr.) in 3600 lb., or ½ to ⅓ of the minimum loss with the old machines.

The day labour with the combined American and buddle process was reckoned to be as follows:—Very hard, stony detritus required 4 or 5 days per cub. fathom; medium and not very stony, 3 or 3½ days; gravel and small shingle, 2 or 2½ days; sands already washed, 1½ day. From this, the advantage of the American method as compared with horses and machinery will be evident. Only in the first case would the expenditure in labour equal or even exceed machine washing.

The following will give a general idea of the gain effected by this method of working. At Latkin's Alexéiefsky placer, on the Untuguna, worked during the bad harvest years 1861–62 (1863 alone having been better), the uppermost layers were stony and clayey, the middle stratum friable but stony, and the lowermost very loose. The financing was generally on the cash system, though partly on credit, and the average taken for the three years came to 234 *rubles* (29*l.*) per man employed. At two other neighbouring placers, belonging to the same owners, worked in the old fashion, the average was 257 *rubles* (32*l.*), a convincing proof of the superiority of the American method. And the work is not at all difficult for the men; the usual hours are from 5 A.M. to 4 or 5 P.M., allowing 2 hours for meals and rest. But some expert hands finish their work by 3 P.M., without knocking off. They are paid by the cubic fathom. Those who fill the boxes work in pairs, and receive at the rate of 80 *kopecks* (2*s.*) for the first fathom, called "the master's," and double this for any more, such extra quantity being termed *staratelsky.* Every labourer may therefore earn 1 *ruble* 20 *kopecks* (3*s.*) per diem, though some fail to get through their second fathom. Good workmen, however, always accomplish their task. Those on the so-called tail-race earn less, —under 50 *kopecks* (15*d.*) on ordinary days, and 80 *kopecks* (2*s.*) on holidays; but their work is lighter and simpler, consisting in merely keeping the trench clear by throwing out the washed sands as they are brought down from the lowest trough. These men, who have to be continually in wet and damp, wear boots of raw, undressed hide over wading stockings. When the alluvium happens to be very gravelly or sandy, the trenches are liable to become choked up; but this difficulty is overcome by increasing the number of hands. Of course, with the American style of working, the subsoil or bed on which the detritus rests becomes covered over with waste sand and shingle, and ought therefore to be thoroughly cleared of alluvium in the progress of the work. Besides the tail-races, of which there should be one for every 4 or 5 rows of troughs, draining ditches have to be dug, to prevent the beds of alluvium from becoming flooded, and stopping the work. Of course, there must also be a main drain, to receive the discharge of the whole digging. Pumps cannot be used with the American method, one of its chief disadvantages, because it renders it inapplicable to those placers which cannot be drained in the usual way. The lines or rows of troughs are lengthened or moved according to the daily progress of the work, which in a great measure depends on the thickness of the auriferous stratum. Very long lines require too many troughs, and necessitate extra labour to prevent them from silting up. The usual plan is to move them once a week, and this is done with the smallest possible sacrifice of time, so that the task set to the men on such days is only ½ to ¾ cub. fathom less than on ordinary work-days. As soon as the washing is over, the grey sediment containing the gold is collected from the troughs, and the final process of sifting it is effected in hand-bowls by special workmen, of whom there are usually 2 in each digging; but if there should not be more than 5 rows of troughs, one is sufficient. All the troughs are then taken off their supports, including the broad one at the tail end, in which all the others unite, and the whole apparatus is moved nearer the gravel wall of the placer, where they are again set up, the straight lines in the centre having 2 or 3 lengths each, the crooked or side lines 3 or 4. On alternate days, as the stratum is worked away, a length is added to each row, and so on, till those in the centre are 5 lengths long, or the distance from the tail is too great, or the reservoir which supplies the water for washing is too close. This reservoir is usually filled by damming the stream, or connecting with it by means of small aqueducts. In 1866, the American method was introduced at the Petropavlofsk placer, situated on a spring in a more remote part of the Yenisei gold-fields where the detritus was strong and clayey. It took here 3½ days on an average to wash 1 cub. fathom, but the system was found to work satisfactorily, and has been continued ever since, the aggregate cost averaging 270 or 280 *rubles* (34 to 35*l.*) per man for the whole year. Attempts were made to work two placers on the Murojnaia in 1866-67 with the American method, but they failed owing to the slope in this river valley being too gradual;

1 cub. fathom cost here 3½ to 4½ days' labour. As to the wood for manufacturing the troughs, red pine is the best, because it is lighter than larch, but any wood will answer the purpose. Should the timber not be thick enough to saw into wide planks, the bottom of the box may be made of two, and the sides of single deals, securely fastened together with 4 or 5 1-in. nails; for the props or stands, the outer slabs of the tree answer as well as anything. The tail-trough is 4 ft. 8 in. or more in width, by 12 ft. long, and has a flooring of laths to catch any gold that may chance to pass.

It will be interesting to glance at the results of working on the American system.

At the Uspensky and Rojdestvensky placers, 110 men assisted by 17 horses washed 40,000 tons of detritus and obtained 135 lb. of gold. The proportions of detritus and peat were as 2 to 5; the average yield of gold was 65 *doilias* (44¼ gr.) per 3600 lb. In 1864, at the same placers, 190 men and 25 horses washed 62,000 tons and obtained 213 lb. of gold, with an average of 54 *doilias* (36¾ gr.), and a proportion of alluvium to peat as 2 to 4; and in 1865, 165 men and 28 horses washed 61,000 tons and obtained 220½ lb. of gold, with an average yield of 58 *doilias* (39½ gr.), and a proportion of 4 to 7. At the Alexéiefsky placer, in 1863, 90 men with 15 horses washed 30,000 tons, and obtained 81 lb. of gold, the average yield being 42 *doilias* (28½ gr.) per 3600 lb., and the proportion of detritus to peat as 2 to 5. At the Sovremionny placer, in 1865, 90 men and 20 horses washed 22,600 tons, and obtained 105½ lb. of gold, with an average of 73 *doilias* (49½ gr.), and a proportion of detritus to peat as 1 to 3. These figures speak for themselves, and show that it was possible to increase the amount of work, notwithstanding unfavourable conditions in the proportion of detritus to peat.

The cost of working the Uspensky and Rojdestvensky placers was 266 *rubles* (33*l.*) per man all round; whilst that of other placers located by Latkin came to 270 *rubles* (34*l.*), a wide difference, if it be remembered first that 10 *rubles* (25*s.*) per man were paid for the privilege of using the American system, and secondly that supplies and forage were 30 to 35 *kopecks* (9*d.* to 10½*d.*) per *pud* (36 lb.) dearer. The saving may therefore be reckoned at 30 and even 40 *rubles* (75*s.* to 100*s.*) per man. All this proves the advantage of the American method of washing in many localities, particularly with small gangs of men, and there can be no doubt that if the industry were thrown open to all classes, many placers would be worked upon it, because the capital required is small, the risk consequently less, and therefore the margin for profit might also be less than under the old costly and venturesome system, where the miner had often to advance a large sum 8 months before he got any return, and sometimes lost instead of gaining in the end, especially if he worked on borrowed capital, for which he paid a high rate of interest. A placer can be worked on the American system with gangs of 20, 40, 50, 60, 70, and up to 100 men, with 10 to 20 horses to remove the peat and for other work. The capital required would not be more than 5000 to 14,000 *rubles* (625 to 1750*l.*). If the layer of detritus were thick enough, say half the depth of the peat, the placer might still be profitably worked, even though the average yield were only 40 *doilias* (27½ gr.). Of course, the smaller the yield, and the thicker the peat, the more labour is necessary; on the other hand, the thinner the peat, and the more favourable the detritus, the more advantageously can the digging be worked. Thus, with equal proportions of peat and detritus, a digging which yielded only 32 *doilias* (21¾ gr.) might still be profitably worked, especially if the detritus were of a loose, easily-washed kind, and water were abundant. If the detritus exceed the peat in thickness, the American system will wash alluvium containing only 24 *doilias* (16⅓ gr.) per 3600 lb., whereas with the old method such a poor digging could not have been worked, unless the peat were exceptionally thin, and the detritus very loose and of great thickness.

Some additional fragmentary remarks on the Russian gold-fields will be found in the works of the following authors (quoted in the Bibliography):—Atkinson, Chappe, Cottrell, Gmelin, Grant, Lansdell, Murchison, Ravenstein, Rose, Smyth, Strahlenberg; also in the three periodical publications below:—'Annuaire du Journal des mines de Russie' (continued as 'Gorny Journal'), 'Bulletin Académie Impériale des Sciences,' and Erman's 'Archive von Russland.'

SUMATRA.—Tavernier (1678) relates that in the island of "Achen or Sumatra, after the rainy season, when the torrents are wasted, they find veins of gold in the flints, which the waters wash down from the mountains that lie towards the N.E. Upon the W. side of the island, when the Hollanders come to lade their pepper, the natives bring them great store of gold, but very coarse metal." And in *Asiatick Researches* (1788), it is recorded that "the country of Limong, 70 to 80 miles inland, produces the finest gold and gold-dust on that island. The gold is found in a species of earth composed of a clayish red loam. On digging the earth, it is found to consist of strata of irregular-shaped stone of a mouldering nature, mixed with a red clay, and hard pebbles mixed with a pale-red clay, of a more dense consistency than that of the first stratum." But the most extended account is given by Marsden (1812), whose work will now be drawn upon at some length.

He says that besides vegetable products Sumatra affords many others, the chief of which is gold. This is found mostly in the central parts of the island, none (or with few exceptions) being observed to the southward of Limun [Limong], a branch of Jambi river, nor to the northward of Nalabu, from which port Achin is principally supplied. Menangkabau has always been esteemed the richest seat of it; and this consideration probably induced the Dutch to establish their head factory at Padang, in the immediate neighbourhood of that kingdom. Colonies of Malays from thence have settled themselves in almost all the districts where gold is procured, and appear to be the only persons who dig for it in mines, or collect it in streams; the proper inhabitants or villagers confining their attention to the raising of provisions, with which they supply those who search for the metal. Such, at least, appears to be the case in Limun, Batang Asei, and Pakalang Jambi, where a considerable gold-trade is carried on.

It has been generally understood at the English settlements, that earth taken up from the beds of rivers, or loosened from the adjacent banks, and washed by means of rivulets diverted towards the newly-opened ground, furnishes the greater proportion of the gold found in the island, and that the natives are not accustomed to venture upon any excavation that deserves the name of mining; but our possession of the settlements that belonged to the Dutch enabled us to form juster notions on the subject, and the following account, obtained from well-informed persons on the spot, will show the methods pursued in both processes, and the degree of enterprise and skill employed by the workmen.

In the districts situated inland of Padang, which is the principal mart for this article, little is collected otherwise than from mines (*tambang*), by people whose profession it is to work them, and who are known by the appellation of *orang gulla*.

The metal brought down for sale is for the most part of 2 sorts, distinguished by the terms *amas supayang* and *amas suñgei-abu*, from the names of places where they are respectively procured. The former is what we usually call rock-gold, consisting of pieces of quartz more or less intermixed with veins of gold, generally of fine quality, running through it in all directions, and forming beautiful masses, which, being admired by Europeans, are sometimes sold by weight as if the whole were solid metal. The mines yielding this sort are commonly situated at the foot of a mountain, and the shafts are driven horizontally, to the extent of 8 to 20 fathoms. The gold to which *suñgei-abu* gives name, is, on the contrary, found in the state of smooth, solid lumps, in shape like gravel, and of various sizes, the largest lump that Marsden saw weighing 9 oz. 15 gr., and one in his possession weighed 8 gr. less than 9 oz. This sort is also called *amas lichin* or smooth gold, and appears to owe that quality to its having been exposed, in some prior state of the soil or conformation of the earth, to the action of running water, and deprived of its sharp and rough edges by attrition. This form of gravel is the most common in which gold is discovered. Gold-dust or *amas urei* is collected either in the channels of brooks running over ground rich in the metal, in standing pools of water occasioned by heavy rains, or in a number of holes dug in a situation to which a small rapid stream can be directed.

The tools employed in working the mines are an iron crow 3 ft. in length, called *tabah*, a shovel called *chañgkul*, and a heavy iron mallet or hammer, the head of which is 18 in. in length and as thick as a man's leg, with a handle in the middle. With these, they beat the lumps of rock till they are reduced to powder, and the pounded mass is then put into a sledge or tray 5 or 6 ft. long and 1½ broad, in the form of a boat, and thence named *bīdu*. To this vessel, a rope of *iju* is attached, by which they draw it, when loaded, out of the horizontal mine, to the nearest place where they can meet with a supply of water, which alone is employed to separate the gold from the pulverized quartz.

In the perpendicular mines, the smooth or gravel gold is often found near the surface, but in small quantities, improving as the workmen advance, and again often vanishing suddenly. This they say is most likely to be the case, when, after pursuing a poor vein, they suddenly come to large lumps. When they have dug to the depth of 4, 6, or sometimes 8 fathoms (which they do at a venture, the surface not affording any indications on which they can depend), they work horizontally, supporting the shaft with timbers; but to persons acquainted with the *bergwerken* of Germany or Hungary, these pits would hardly appear to merit the appellation of mines. In Sumatra, however, as in Siberia, the hills yield their gold by slightly working them. Sand is commonly met with at the depth of 3 or 4 fathoms, and beneath this a stratum of *napal* or steatite, which is considered as a sign that the metal is near; but the least fallible mark is a red stone, called *batu kawi*, lying in detached pieces. It is mostly found in red and white clay, and often adhering to small stones, as well as in homogeneous lumps. The gold is separated from the clay by means of water poured on a hollow board, in the management of which the persons employed are remarkably expert.

In these perpendicular mines, the water is drawn off by hand in pails or buckets. In the horizontal, they make 2 shafts or entries in a direction parallel to each other, as far as they mean to extend the work, and there connect them by a cross-trench. One of these, by a difference in their respective levels, serves as a drain to carry off the water, whilst the other is kept dry. They work in parties of 4 or 5 to 40 or 50 in number, the proprietor of the ground receiving ½ the produce, and the *entrepreneurs* the other; and it does not appear that the prince receives any established royalty. The hill people affect a kind of independence or equality, which they express by the term of *sama rata.*

It may well be imagined that mines of this description are very numerous, and, in the common estimation of the natives, they amount to no fewer than 1200 in the dominions of Menangkabau. A considerable proportion of their produce (perhaps ⅓) never comes into the hands of Europeans, but is conveyed to the eastern side of the island; and yet Marsden was assured on good authority, that 10,000 to 12,000 oz. have annually been received, on public and private account, at Padang alone; at Nalabu, about 2000; Nattal, 800; and Moco-moco, 600. The quality of the gold collected in the Padang districts is inferior to that purchased at Nattal and Moco-moco, in consequence of the practice of blending together the unequal produce of such a variety of mines, which in other parts it is customary to keep distinct. The gold from the former is of the fineness of 19 to 21, and from the latter places is generally of 22 to 23 carats. The finest that passed through Marsden's hands was 23 carats 1½ gr., assayed at the Tower of London. Gold of an inferior touch, called *amas muda*, from the paleness of its colour, is found in the same countries where the other is produced. Marsden had some assayed which was 2 carats 3 gr. worse than standard, and contained an alloy of silver, but not in a proportion to be affected by acids. He saw gold brought from Mampawah, in Borneo, which was in the state of a fine, uniform powder, high-coloured, and in its degree of fineness not exceeding 15 or 16 carats. The natives suppose these differences to proceed from an original essential inferiority of the metal, not possessing the art of separating it from the silver or copper. In this island, it is never found in the state of ore, but is always completely metallic. A very little pale gold is now and then found in the Lampong country.

Of those who dig for it, the most intelligent, distinguished by the name of *sudagar* or merchants, are entrusted by the rest with their collections, and carry the gold to the places of trade on the great eastern rivers, or to the settlements on the west coast, where they barter it for iron (of which large quantities are consumed in tools for working the mines), opium, and the fine piece-goods of Madras and Bengal, with which they return, heavily loaded, to their country. In some parts of the journey they have the convenience of water carriage, on lakes and rivers; but in others they carry on their backs a weight of about 80 lb., through woods, over streams, and across mountains, in parties generally of 100 or more, who have frequent occasion to defend their property against the spirit of plunder and extortion, which prevails among the poorer nations, through whose districts they are obliged to pass.

It has generally been thought surprising that the European Companies who have so long had establishments in Sumatra, should not have considered it an object to work these mines upon a regular system, with proper machinery, and under competent inspection ; but the attempt has in fact been made, and experience and calculation may have taught them that it is not a scheme likely to be attended with success, owing, among other causes, to the dearness of labour, and the necessity it would occasion for keeping up a force in distant parts of the country, for the protection of the persons engaged and the property collected. Europeans cannot be employed upon such work in that climate, and the natives are unfit for (nor would they submit to) the laborious exertion required to render the undertaking profitable. A detailed, and in many respects interesting, account of the workings of a gold-mine at Sileda, with a plate representing a section of the mine, is given by Elias Hesse, who, in the year 1682, accompanied the Bergh-Hoofdman, Benj. Olitzsch, and a party of miners from Saxony, sent out by the Dutch East India Company for that purpose. The superintendent, with most of his people, lost their lives, and the undertaking failed. It is said at Padang that the ore proved to be uncommonly poor. Many years later, trial was made of a vein running close to that settlement ; but the returns not being adequate to the expense, it was let to farm, and in a few years fell into such low repute as to be at length disposed of by public auction, at a rent of 2 Spanish dollars. Following is an extract of a letter from Jas. Moore, a servant of the Company, dated from Padang, in 1778 : "They have lately opened a vein of gold in the country inland of this place, from which the governor at one time received 150 *tials* (200 oz.). He has procured a map to be made of a particular part of the gold-country, which points out the different places where they work for it ; and also the situation of 21 Malay forts, all inhabited and in repair. These districts are extremely populous, compared to the more southern part of the island. They collect and export annually to Batavia, about 2500 *tials* of gold from this place : the quantity never exceeds 3000 *tials*, nor falls short of 2000." This refers to the public export on the Company's account. The English Company also, having intelligence of a mine said to be discovered near Fort Marlborough, gave orders for its being worked ; but if it ever existed, no trace remained in Marsden's time.

Thomas Barnes, who journeyed from Moco-moco to Pakalang Jambi in 1818, generally corroborates Marsden. Crawfurd (1820), who mainly summarizes from the records of others, gives the following table of Archipelago gold imported into Calcutta :—

TABLE EXHIBITING THE QUANTITIES AND VALUE OF THE GOLD OF THE INDIAN ARCHIPELAGO, IMPORTED INTO CALCUTTA.

Year.	From the west coast of Sumatra.					From Borneo and the rest of the Archipelago.					Total.				
	Pure gold.	Value at 4*l.* 5*s.* an oz.				Pure gold.	Value at 4*l.* 5*s.* an oz.				Pure gold.	Value at 4*l.* 5*s.* an oz.			
	oz.	$	c.	£	*s.*	oz.	$	c.	£	*s.*	oz.	$	c.	£	*s.*
1801	2,451	46,296	67	10,416	15	23,764	448,875	56	100,997	0	26,215	495,172	22	111,413	15
1802	692	13,071	11	2,941	0	9,844	185,942	22	41,837	0	10,536	199,013	33	44,778	0
1803	1,008	19,040	0	4,284	0	7,795	147,238	89	33,128	15	8,803	166,278	89	37,412	15
1804	580	10,955	56	2,465	0	8,791	166,052	22	37,361	15	9,371	177,007	78	39,826	15
1810	4,538	85,717	78	19,286	10	11,863	224,078	89	50,417	15	16,401	309,796	67	69,704	5
1811	611	11,541	11	2,596	15	5,910	111,633	33	25,117	10	6,521	123,174	44	27,714	5
1812	10,570	199,655	56	44,922	10	16,322	308,304	44	69,368	10	26,892	507,960	0	114,291	0
1813	6,374	120,397	78	27,089	10	19,540	369,088	89	83,045	0	25,914	489,486	67	110,134	10
1814	7,206	136,113	33	30,625	10	8,336	157,457	78	35,428	0	15,542	293,571	11	66,053	10
Total	34,030	642,788	89	144,627	10	112,165	2,118,672	22	476,701	5	146,195	2,761,461	11	621,328	15
Average.	3,781 1/9	71,420	99	16,069	14	12,462 7/9	235,408	2	52,966	16	16,243 8/9	306,829	1	69,036	10

To this he adds the annexed comparative table :—

TABLE EXHIBITING THE ESTIMATED ANNUAL AMOUNT OF THE GOLD OF THE INDIAN ARCHIPELAGO, COMPARED WITH THAT OF OTHER COUNTRIES.

		Pure gold.	Value at £4 5*s.* an oz.	
		oz.	$	£
Exports from the east and west coasts of Sumatra..	oz. 25,080			
Produce of Achin	10,450			
Total estimated produce of Sumatra		35,530	671,125	151,003
Estimated produce of the mines of Montradak in Borneo		88,362	1,669,058	375,538
Produce of all other parts of the Archipelago, estimated at one-fifth of the whole		30,973	585,045	131,635
Total annual produce of the Archipelago ..		154,865	2,925,228	658,176

Moor (1837) says that gold is the only metal which is found in abundance in Sumatra, and this is confined to the mountains in the interior or the valleys at their feet. The gold of Jambi and Indragerie is brought from the mountains of Menangkabau, and the little exported from Siak and Dili from the hilly countries of the Battaks. The greater part of this finds its way to the western coast of Padang, Bencoolen, Nattal, and other places.

According to Bickmore (1868), in the vicinity of Mount Ophir (0° 1' 10" N., 100° E.) gold has been obtained for centuries. The quantity procured in Sumatra is wholly unknown, but, judging from what is used in ornaments, it must be considerable. It is always bought and sold in the form of "dust," and has never been coined for money in any part of the Archipelago, except at Achin. On the way to Kotanopan he passed along a large foaming brook, in which the *opziener* of that district assured him the natives were accustomed to wash for gold. And after entering the S. end of the valley of Mandéling, he was repeatedly informed that the natives obtained gold by washing in the vicinity. At Fort Elout, the Resident showed him a nugget as large as a pigeon's egg, which a native had just found in a neighbouring stream, where they had certainly been at work for centuries. In the mountains west of Ran only is the gold taken from the rock.

Col. Yule (1875) says Sumatra was long famous for its produce of gold. The export is estimated by Crawfurd at 35,530 oz.; but no doubt it was much more when the native states were in a condition of greater wealth and civilization, as they undoubtedly were some centuries ago. Valentyn says that in some years Achin had exported 80 *bahars*, equivalent to 32,000 or 36,000 lb., but this figure is discredited by Yule in the Encyclopædia Britannica (i. 96).

The interesting report (1880) of John Munday, on the gold-mines of the west coast of Sumatra, was referred to in the *Mining Journal*, l. 732; and a review of ancient allusions to gold in Sumatra and of the geology of the island is given by Verbeek (1878–9), in a pamphlet published at Batavia, and summarized in *Annales de l'Extrême Orient*, i. 185–92. Veth's new work, quoted in the Bibliography, may also be consulted.

THIBET.—Thibet has for ages been remarkable among auriferous countries by reason of the tradition concerning the existence of gold-digging ants. This fable was perpetuated by Herodotus, Strabo, Megasthenes, Arrian, Ktesias, Phôtios, and other ancient writers, and has been the subject of much learned discussion, till satisfactorily explained by Sir Henry Rawlinson and Prof. Schiern, independently yet in parallel terms.

Megasthenes gives the following account of these ants. Among the Derdai, a great tribe of Indians, who inhabit the mountains on the eastern borders, there is an elevated plateau, about 3000 stadia in circuit. Beneath the surface there are mines of gold, and here accordingly are found the ants which dig for that metal. They are not inferior in size to wild foxes. They run with amazing speed, and live by the produce of the chase. The time when they dig is winter. They throw up heaps of earth, as moles do, at the mouth of the mines. The gold-dust has to be subjected to a little boiling. The people of the neighbourhood, coming secretly with beasts of burden, carry this off. If they came openly, the ants would attack them, and pursue them if they fled, and would destroy both them and their cattle. So to effect the robbery without being observed, they lay down in several different places pieces of the flesh of wild beasts, and when the ants are by this device dispersed, they carry off the gold-dust. The Derdai are the Dardæ of Pliny, the Daradrai of Ptolemy, the Daradas of Sanskrit literature, and the Dards of to-day. The plateau mentioned is the table-land of Chojotol.

Phôtios relates that gold is also a product of India. It is not found in rivers, and washed from the sands, like the gold of the river Paktôlos; but is found on those many high-towering mountains, which are inhabited by the "griffins," a race of four-footed birds, about as large as wolves, having legs and claws like those of the lion, and covered all over the body with black feathers, except only on the breast, where they are red. On account of those birds, the gold with which the mountains abound is difficult to be got.

Ktesias says that the "gryphon," an Indian animal, is, so far as he can learn, four-footed like the lion, and has claws of enormous strength, closely resembling his. It is described as having feathers on its back, and these black, while the breast feathers are red, and those of the wing white. Its neck is variegated with feathers of a bright blue; its beak is like an eagle's; and its head like the representations which artists give of it in paintings and sculptures. Its eyes are said to be fiery red, and it builds its nest upon the mountains, and, as it is impossible to catch these birds when full grown, they are caught when quite young. The Baktrians, who are next neighbours to the Indians, give out that these birds guard the gold found in the regions which they haunt, and that they dig it out of the ground, and build their nests with it, and that the Indians carry off as much of it as falls to the ground. The Indians however, deny that the "gryphons" guard the gold, alleging, what is highly probable, that gold is a thing "gryphons" have no use for; but they admit that when these birds see them coming to gather the gold, they become alarmed for their young, and attack the intruders. Nor do they resist man only, but beasts of whatever kind, gaining an easy victory over all, except only the elephant and the lion, for which they are no match. The "gryphons" then, being so formidable, the natives of these countries go not to gather gold in the day-time, but set out under cover of night, when they are least likely to be detected. Now the auriferous region which the "gryphons" inhabit is a frightful desert, and those who make a raid upon the gold, select a moonless night, and set out armed, the expedition being 1000 or even 2000 strong. They take with them mattocks for digging the gold, and sacks in which to carry it away. If they are unobserved by the "gryphons," they have a double share of good luck, for they not only escape with their lives, but bear a freight of gold in triumph home, where the metal having been purified by those who are skilful in smelting ores, they are recompensed with overflowing wealth for all the hazards of the enterprise. Should they, on the other hand, be detected in the act of theft, certain death would be their fate.

Ktesias learned by inquiry that they did not return home till after an absence of 3 or 4 years.

Heeren identifies Herodotus' pismires, "Indians living near the Caspatyras and the country of Pactyica," with the desert of Gobi, remarking that the desert streams which run to the east and lose themselves in the sand or in inland seas, all carry down a quantity of gold-sand, while the lofty mountains which limit the desert are rich in veins of gold.

Capt. Turner (1806) alludes to the finding of gold-dust in the beds of rivers, generally attached to small pieces of stone, with every appearance of having been part of a larger mass.

Moorcroft (1816), who travelled to Lake Manasarovara, in Hundes [Un-dés], a province of Little Thibet, found that the hills (which are stated to be rich in gold) near Mehal, on the head-waters of the river Sutlej, are granite of mixed colours, the red predominating, with horizontal strata of quartz and small fibrous veins of a white material like agate, descending perpendicularly; where the rock has been exposed to the weather, its surface is broken into small pieces, having little more cohesion than clay burnt in the sun. This decomposition is effected, he supposes, in consequence of the different materials of which the mass is composed, not being intimately united, and water entering the fissures, where it congeals, and bursts the structure. The gold here is separated by washing. The plain is stony, about ½ mile in breadth and length, bounded partly by heights, and partly by the Sutlej. It is full of shallow pits, made by persons who have dug for gold-dust, and left heaps of stones by the sides of the excavations. At 306 paces, he ascended to another flat, which has likewise been dug. At 1835 paces, he reached a small flat where has been cultivation, and saw caves of gold-mines in the rock to the left, now deserted. At 5975 paces, he reached a house near which are two gold-mines with tunnels under the surface. Heretofore the excavations were perpendicular. The earth is dug out and carried to the brook to be washed. At 5551 paces, the valley narrows to 600 yd.; surrounding hills are said to contain gold, which is sometimes found in lumps of considerable size.

Lieut. Strachey (1846), another traveller in this region, found that the principal gold-mines, Sar Chaka, were farmed by a Sarpún, who paid to the Lhasa treasury 17,000 *rupees* (1700*l.*) per annum, and had 170 miners at work, to whom he sent supplies from Pruang, as the country was barren. These mines are worked in shafts and galleries underground; the gold is found in the pure native state in quartz. It undergoes no other process than washing and sifting, before it enters the market, and after that requires little or no refining. The metal is sometimes found in large masses; the Lama of Gangri is said to have one weighing 5 *nega*, i. e. nearly 1 *seer* (2 lb. 1 oz.), and there are problematical stories of other masses, of such supernatural size and shape that the Lamas pronounced them spiritually dangerous, and insisted on their being consigned to earth again.

According to Capt. Montgomerie (1865–67), 4 miles N. of Lhasa is a hill called Toti-phu, in which gold exists, and also near the monasteries Debang and Ramoche; but it is not worked. Gold is, however, worked to a very slight extent near the monasteries by the priests; but should they, in their search, discover a nugget of large size, it is immediately replaced in the earth, under the impression that the large nuggets have life, and germinate in time, producing the small lumps, which they are privileged to search for. To the N.E. of Lhasa, and 1½ month's journey from it, at Sarka or Thok, gold is extracted in large quantities, there being no prohibition as to working it.

Col. Walker (1867–8) believes from previous information that gold was first discovered to be abundant at Thok-Jalung about 8 or 9 years ago. The Pundit found the part of the gold-field that was being worked to be a great excavation, 10 to 200 paces in width and 25 ft. in depth, access to the bottom being by means of steps and slopes, the earth as dug out being thrown upon either side. The excavation was about a mile long. The digging is carried on with a long-handled kind of spade, and occasionally with an iron hoe. A very small stream runs through the gold-field, and is put to good use for washing the gold out of the soil. The diggers dam up the water and leave a sloping channel for it to escape by. A cloth is spread at the bottom of the channel, and kept down by a number of stones, so as to make the bottom uneven. One man brings earth from the excavation and sprinkles it over the channel, whilst another man drives water down the channel by means of a leather bag. The water carries the lighter soil right away, but the pieces of gold fall into the uneven places, and are easily collected in the cloth by lifting up the stones. The yield of gold seems to be large, and the finds occasionally very heavy—the Pundit saw 1 nugget of about 2 lb. weight (75 *tolahs*). The diggers say they can recognize the soil that contains gold at once; but judging from the large number of gold-fields that have been used at one time around Thok-Jalung, and are now more or less abandoned, the Thibetan gold-diggings seem to be quite as capricious as those of California or Australia. From what the Pundit heard, there is a whole string of gold-fields extending all the way from Lhasa to Rudok, along the route which must run close to the northern watershed of the Brahmaputra, probably in the depression to the north of it. The gold-fields are carefully watched by the Lhasa authorities; a gold commissioner, called Sarpún, superintends the whole of them, and each field has a separate master. Any individual is allowed to dig, provided he pays the annual tax of 1 *sarshoo* weight of gold, which is about ½ *tolah* or ⅖ oz. The

Pundit says that in all his travels he never experienced such intense cold as he did at Thok-Jalung, owing, as he thought, to the high cold wind that was always blowing, more than to the great elevation, viz. 16,330 ft. above the sea. The tents of the diggers are always pitched in pits 7 or 8 ft. below the surface of the ground, so as to keep out the wind. Spite of the cold, the diggers prefer working in the winter, and the number of their tents, which in summer amounts to 300, rises to nearly 600 in winter. They prefer the winter, as the frozen soil then stands well, and is not likely to trouble them much by falling in.

A later (1868–9) report of the Trigonometrical Survey says that the district Jung Phaiyu-Pooyu contains several gold-fields, and has a Sarpon or gold commissioner of its own. Whilst marching from Rudok to Thok-Jalung, the Pundit heard minute descriptions of no less than 7 separate gold-fields, viz. :—Thok-Sarkong, Thok-Dikla, Thok-Ragyok, Thok-Thasang, Thok-Maroobhoob, Gunjee-Thok, and Thok-Nianmo, besides those of Thok-Sarlung and Thok-Jalung, which he actually visited, and those of Phaiyu-Pooyu, of which he heard vaguely. The Pundit understands the word Thok to mean a mine. In marching S. from Thok-Jalung, the Pundit appears to have left the gold-bearing rocks, and from the information he received, the line of gold-fields is continued more to the N. ; but it is evident that this part of Thibet contains an inexhaustible supply of gold. Thok-Sarlung at one time had been the chief gold-field of the district, but had been in a great measure abandoned on the discovery of the Thok-Jalung gold-field.

Sir Henry Rawlinson's remarks (*Pall Mall Gazette*, Mar. 16, 1869; *Indian Antiquary*, iv. 225) on these reports of the Pundit's researches and travels are as follows :—" Now, then, for the first time, we have an explanation of the circumstances under which so large a quantity of gold is, as is well known to be the case, exported to the west from Khotan, and finds its way into India from Thibet; and it is probable that the search for gold in this region has been going on from a very remote antiquity, since no one can read the ex-Pundit's account of Thibetan miners living in tents some 7 or 8 ft. below the surface of the ground, and collecting the excavated earth in heaps previous to washing the gold out of the soil, without being reminded of the description which Herodotus gives of the ants in the lands of the Indians bordering on Caspatyrus (or Kashmir) which made their dwellings underground, and threw up sand-heaps as they burrowed, the sand which they threw up being full of gold. "

Prof. Schiern points out that the tradition was mentioned in writings of the middle ages, and those by Arabian authors. It survived among the Turks. Strabo and Albertus Magnus treated the whole story as a fiction. Xivrey supposed that the animals had become extinct, owing to the *auri sacra fames*. Major Rennell supposed that the dwellers in mounds were termites [white ants]. Humboldt's observations in Mexico on the habit of certain ants to carry about shining particles of hyalith was quoted by those who believed that the animals were really ants. Other authorities suggested that they were marmots, jackals, foxes, or hyænas. Pliny having stated that horns of the Indian ant were preserved in the Temple of Hercules at Erythræ, Samuel Wähl, who maintained the hyæna theory, proved equal to the difficulty by suggesting that the horns might have been a *lusus naturæ.* Prof. Schiern ingeniously argues that the horns had been taken from the skins of animals which formed the garments of the miners. It seems possible, however, that they were samples of the pickaxes made of sheeps' horns, which, as is mentioned on p. 361, are used to the present day by the miners in Ladak.

Prof. Schiern further points out that ancient writers say that the ants chiefly worked in winter, and connects this with the statement of the Pundit quoted on p. 465. In conclusion, he writes :—" For us, the story partakes no longer of the marvellous. The gold-digging ants were originally neither real ants, as the ancients supposed, nor, as many eminent men of learning have supposed, larger animals mistaken for ants on account of their subterranean habits, but men of flesh and blood, and these men Thibetan miners, whose mode of life and dress were in the remotest antiquity exactly what they are at the present day."

Cooper (1870) found at 1 day's journey from Lithang, on the road to the Taso Mountains, vast masses of quartz and granite scattered over the sterile surface. A thousand tiny streams trickled across his path, in the sands of which, as the hoofs of his cattle ploughed them up, he saw abundance of scaly gold. But gold, like all else of a yellow colour, in Thibet is sacred to the grand Lama; at least, so the 2 spies informed him, and he was forbidden even to take up a handful of the golden sand.

Col. Yule (1875) says that gold is stated still to be very plentiful in the mountain called Gulan-Sigong, to the N.W. of Yunnan, adjoining the great Eastern branch of the Irawadi, and the Chinese traders go there to barter for it.

Capt. Trotter (1877), in giving an account of the Pundit's journey to Great Thibet from Leh in Ladak to Lhasa, says the Pundit found that the gold-fields of Thok-Daurákpa, in this portion of Thibet, were of much less importance than those he had visited at Thok-Jalung, in Western Thibet, on a former exploration. At Thok-Daurákpa, the diggers mostly dwell in caves excavated in the earth. These habitations, which are locally termed *phúkpá*, are 32 in number, and contain 5 to 25 individuals in each, according to the wealth of the proprietors, who do not appear to select these buildings from choice, but rather from necessity, caused by the proximity of the Khampa robbers, who have a habit of cutting down first the tents and then the owners. These underground caves are naturally far more secure than tents would be, and one man well armed could defend one of them against a large number of assailants. Besides these caves, there were also some 7 or 8 tents belonging to travelling merchants and recent arrivals. The diggers were mostly Changpas, from the Nákcháng district, to the E. and S.E. of the gold-fields; but there were also others from Western Thibet and from Janglaché, a large town on the Brahmaputra, 5 or 6 days west of Shigátzé.

The proprietors of each *phúkpá* have also their own gold-pit (while at Thok-Jalung the whole of the diggers work in one large excavation), in which they work in the day-time only. One or two men are generally employed in quarrying the stone in which the gold is found. The pieces of stone are lifted up in baskets to the brink of the pit, and are there pounded into small fragments, which are deposited on a cloth, which is arranged on a slight slope, and kept down by a number of stones, so as to make the surface uneven. Water is then poured over it, and carries away the lighter portion of the soil, leaving the gold in the uneven receptacles that have been made for it. The largest piece of gold seen by the Pundit at Daurákpa was about 1 oz. in weight. Unfortunately for the diggers, water is not found within a mile of the gold-fields, and has to be brought that distance in skins on donkeys, which are specially kept for the purpose.

The gold of Thok-Daurákpa is said to be whiter and of better quality than what is found further west. It is, however, more difficult to obtain, both on account of the soil, or rather rock, in which it is found being much more difficult to break up than the softer soil of Thok-Jalung, and on account of the distance from which the water has to be brought. At Jalung a stream runs through the gold-fields. The Pundit believes that there are enormous tracts of land where gold is to be obtained by digging, but where the absence of water would render the working of them unremunerative.

The Thok-Daurákpa and Thok-Jalung gold-fields are under the same Sarpon, who makes the round of all the Thibetan gold-fields once a year to collect the taxes.

It would appear that the importance and value of the Thibetan gold-fields have been considerably overrated. The Pundit states that, besides the half-dozen places where gold-digging is now carried on in the neighbourhood of Thok-Jalung, the only other gold-fields now being worked in Northern Thibet are at Thok-Daurákpa, and two other places, of even less importance, at Tang Jung and Sarka Shyár, both of which are about 6 days' journey farther east. He believes that nearly the whole of the gold collected in Western Thibet finds its way to Gartokh, and ultimately through the Kumauni merchants to Hindustan. He estimates the value of gold brought annually into Gartokh at about 80,000 *rupees*

(8000*l.*). The gold-diggers at Daurákpa dispose of most of their gold either to the Khampas of Garchethol on the west, or the Champas of Nakchangpontod on the east, in exchange for the products of their herds and flocks. The rest of the gold is taken by merchants who bring tea from Lhasa and from China.

Markham (1879) says there are many gold-mines in the provinces of U, Tzang, Chang, Takpo, Kombo, and Kham.

According to Col. Lewin (1879), the gold-fields of Thibet extend along the base of the S. watershed of the Brahmaputra, and the gold-diggers come chiefly from the country round Shigátzé. The mountainous region south of Su-chow was explored by Col. Prjevalsky to a considerable extent, and many abandoned gold-diggings were met with.

On Dr. Regel's journey (1881) from Sigoshur, southwards up the course of the Tallik to the ravine whence it issues as a torrent, and then along a mountain track, several neglected mines, formerly yielding gold and silver, as it was reported, were passed.

TRANS-CAUCASUS.—Both flanks of the Caucasus range, from Stavropol and the Terek on the north to Transcaucasia, Turkey and Persia on the south, contain gold. Wherever metamorphic rocks have been upheaved and transmuted by igneous action, there the precious mineral should be sought. But little progress has been made in gold-prospecting in the Caucasus since the time when Jason and his Argonauts went to Colchis (near the modern Rion) in search of the golden fleece. The country has had too troublous a history to admit of peaceful pursuits. The Caucasus is the borderland of Asia and Europe, and was the gateway and barrier, often the battlefield, of the nations who passed to and fro. The inroads of Scyths, Persians, Parthians, Arabs, Russ, Turks, and mountain tribes uprooted the first germs of civilization derived from the ancient kingdom of Armenia and the Græco-Roman world. Russia, indeed, succeeded, but only after a protracted struggle, in subduing this naturally rich and fertile country. Under circumstances such as these, it could not be expected that mining enterprise should flourish. As early as 1820, gold was discovered in the government of Stavropol, by the Jesuit father Gandry, who obtained it secretly on the left bank of the Terek, opposite the town of Mozdok. Information having been lodged against him, he was banished from Russia in 1828, and carried his secret with him. In 1833, however, a mining engineer of the name of Follendorf was commissioned to investigate the gold, and he found alluvium on the banks of the Terek, 2 miles from the town, containing gold in the proportion of ⅛ *zol.* per 3600 lb., under a layer of peat, sand, and clay, 5 to 8 ft. thick. Deeper borings were stopped by water, and Follendorf was prevented by illness from extending his explorations above the mouth of the Malka and the town of Mozdok. Were careful investigations to be made in this direction, gold would doubtless be found in considerable quantities. But military operations prevented these works from being prosecuted there or in any part of the Caucasus, and it is only within the last few years that gold-seeking may be pursued without hindrance in the government of Stavropol, and on the Terek and Kuban. In the fifth decade of the present century, the well-known mining *entrepreneur*, chamberlain Astashof, received permission to prospect for gold in the Caucasus. He formed an exploring party, which he intrusted to the leadership of Ivanitzky the Second. But their investigations only resulted in the discovery of traces of gold on the Miskalga, and a poor detritus on the Akstafa, where ancient workings were found, from which were taken a piece of gold beaten out flat, some wire, a silver coin, a lump of scoria, and particles of wood. To what people these ancient workings in the Caucasus are attributable is uncertain; probably Armenians long ago knew of and worked the gold-mines.

In 1865, by permission of the Grand Duke Michael, Viceroy of the Caucasus, General Klémanof explored the deposits on the tributaries of the Kur. He found gold, though in small quantities, 22 miles from the village of Delijan, at Karaklis station, on the Bambak, a right tributary of the Khram, which joins the Kur on the right, and on the streams which take their sources on the highlands on which lake Kokcha lies, such as the Hassan-su, Tanz, Shamkhor, Ganja-chai, Terter and Karbakha. Besides which there is gold in Grusia or Georgia and Imeritia. In 1875, mining engineer Prince Tsulukidze discovered auriferous alluvium on the Dambluda, on the estate of the Dambluda works, with an average of ¼ to 1½ *zol.* per 3600 lb. This was the first important discovery of gold in the Caucasus. Lastly the gold found at the mouth of the Rion doubtless came from the headwaters of this river. In the central Caucasus, no gold-seekers have yet ventured to prospect, for that country is inhabited by wild, predatory tribes.

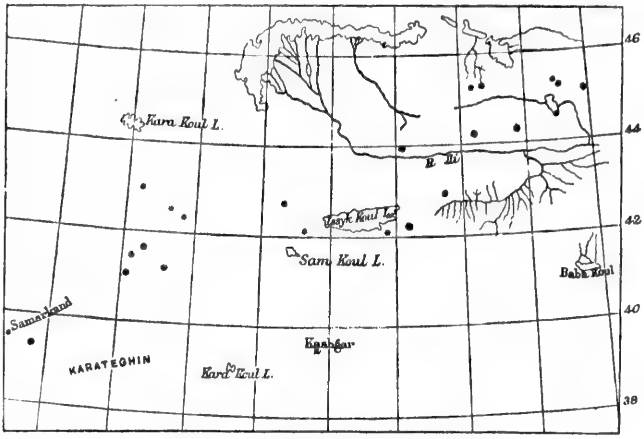
From the preceding, it is evident that the rivers flowing into the Caspian and Black Seas contain the source of much future wealth to Russia, for though the first explorations were unsuccessful, they proved conclusively the presence of gold derived from parent rocks where the detritus is probably much richer, because the gold there is less widely disseminated. When the spurs and chains, especially knots of mountains, come to be thoroughly examined, it will be found that the Kuma, Terek, and Kuban on the northern flank, the Kur, Araxes, and Rion on the southern slope of the range, flow through a region abounding in copper, iron, and silver, and not destitute of gold. But to develop this country it will be necessary to import labour from the Ural, where the population is industrious and experienced in mining, for the inhabitants of the Caucasus share that universal Eastern vice of idleness.

Col. Monteith, in 1833, ascended the Rion or Phasis, some distance to look at the gold-mines; but only found some shafts and furnaces, with signs of copper. If gold ever existed, he thinks it must have been on the Quirilla, and not on the Rion. These two rivers join 12 miles below Kautais, from whence they take the name of Phasis or Rion.

Strabo (Bk. xi. c. ii. § 19, Bohn's Library, ii. 229) observes that the Soanes occupy the heights of Caucasus above Dioscurias (on the Caucasian coast of the Black Sea, near Colchis, and some distance N. of the river Phasis). In their country, the winter torrents are said to bring down even gold, which the barbarians collect in troughs pierced with holes, and lined with fleeces; and hence the fable of the golden fleece.

TURKESTAN.—According to W. H. Johnson (1867), gold is chiefly found in the beds of the streams which issue from the Kiun-Lun range, and in very large quantities about Karangotak, Kiria, and Chira. It is said that 3000 men are daily employed in the gold-fields. The ordinary value of gold in Khotan is Rs. 9 to 10 (18 to 20*s.*) per *tola* (180 gr.), while in Kashmir the same quantity sells for Rs. 17 to 18 (34 to 36*s.*): this circumstance alone will show how abundant gold is, and how large a quantity there must be at the present time in the country.

FIG. 18.



SKETCH-MAP OF TURKESTAN GOLD-FIELDS.

Lloyd (1867) says the neighbourhood of Khinka lake is rich in minerals, gold, silver, platinum, lead, and coal being found there. The Manchûs frequently bring small parcels of gold of fine quality to the settlement for sale, but they rate the market value of the precious metal too high to enable the merchants to purchase much of it.

Williamson (1869) states that gold is found in many places towards the south of the promontory in greater or lesser quantities; but the most famous district is that on the E. coast of Manchuria, to the N. of the Py-li river. Here he passed over gold-diggings and a gold-producing country, about 40 miles in length by 10 broad. He also heard of gold at Kinchau (39° 10′ N., 121° 36′ E.), which may be interpreted the "gold-district city."

Hayward (1870) asserts that the Karakash river skirts the edge of a vast tract of uninhabited country, and the gold found in that river is said to be washed up from the buried treasures in the Takl\u00e1 Mak\u00e1n desert. Gold is found in the N. slopes of the Kiun-Lun, and extensive gold-washings occur on the banks of the rivers E. of Khotan. The country adjacent to Khotan-Daria and the Karakash furnishes a moderate supply.

Shaw (1871) says gold is not allowed to be taken away from Khotan by private individuals, as it is a Government monopoly in the mining country. Khotan is famous for its gold, of which there are several mines under the mountains near Kiria, to the E. of Khotan. This gold-field probably is connected with that to the E. of Rudok and Gartokh, which has lately been visited by one of Major Montgomerie's Pundits. Gold is reported to exist in the mountains between these two scenes of mining operations. At Kiria, the shafts are sunk to some depth to reach the auriferous beds, of which the earth is brought up to the surface, and there washed in cradles. The produce is a kind of coarse "gravel" of gold, consisting of dust mixed with smaller or larger nodules or lumps, none of them, however, being bigger than a broad-bean, and of irregular shapes.

Delmar Morgan (1872) observes with regard to Palladius' expedition in Girin [Chuen-chang], that the trade in gold, found in the N. spurs of the Chang-pŏ-shan mountains, although contraband and punishable by law, is extensively carried on by the Tsziù-fehi ("golden gold-miners"), whose organized bands completely defy the vigilance of the Girin officials.

Lockhart (1872) found at the lake of Khinka a great quantity of gold brought down by the rivers, and also at Cape Nicolaif. When, during the Russian war, soldiers landed on the coast, the inhabitants brought pieces of gold in exchange for empty bottles.

Shaw (1872) says gold-seekers seem to play an important part in these regions; for he lately heard of something resembling a Californian or Australian rush of diggers in the heart of Asia. There is a newly-found gold-field, named Kappa, some 25 days E. of Kiria, to which

1000 diggers have already flocked from all parts during the last year.

The Russian traveller Prjevalsky (1875–78) observes that, like most other countries, Russia has had its romantic El Dorado, which was the country of Little Bukharia, and especially the neighbourhood of Yarkand, and Khotan, reported to be rich in gold-deposits. He sent specimens of the gold-dust which had been taken to Tobolsk for sale. At 1 day's journey from Kiria, gold is obtained in the mountains, and other gold-mines are situated 5 days' march from Cherchen, near the sources of the Cherchen-Daria. The quantity of gold annually produced in these mines is said to be about 19 cwt., which finds its way into Yakub Beg's treasury. Shaw learned that 6 days' journey in an E. and S. direction from Cherchen was a range of mountains resorted to by gold-seekers. The region where the river Ayulla joins the Kaitanak is auriferous, and Printz found a party of gold-seekers prospecting the locality, but gold at that time had not been discovered. From the Chagrin-gol Prjevalsky ascended the valley of the Yarlin-gol, and passed several gold-washings abandoned on account of the Dungan insurrection ; all the streams in the mountains of Kansu are said to abound in the precious ore. The mineral wealth of the mountains of Kansu consists in its coal-fields and gold, which, according to the natives, is found in almost every mountain stream. The natural wealth of the Urumchi district is considerable. In the mountains south of Manas, alluvial gold is found everywhere.

Col. Gordon (1876) found a great desire to keep Khotan secluded, on account of its gold-fields, which contribute largely to the state treasury. About the end of his stay at Kashgar the distant governors began to arrive, according to custom, with the annual imperial revenue and offerings from their provinces, followed by Niaz Beg of Khotan, who led in 2 *arabas* (carts), each carrying 1500 *jings* (equal to about 1800 lb.) of gold and silver.

According to Dr. Cayley, the gold-fields of Khotan are practically inexhaustible, and the gold is obtained from them without any labour or difficulty.

Capt. Trotter (1878) states that the inhabitants of Kiria go W. towards the Yurung-Kásh [Ilchi] river (near Khotan or Ilchi) for gold.

Finally, Major Clarke (1880) remarks that it was thought at one time that gold-mining would become an industry, and that Kuldja was destined to be the El Dorado of Central Asia ; but these expectations do not appear to be any nearer realization now than they were in the time of Peter the Great. Mouchketoff, the Russian Government geologist, who has been engaged for some time in mining explorations in Central Asia, reports that gold is found in small quantities in the auriferous sands of the basins of the Ili, the Tekess, and the Zerafshan (the latter name signifies "gold-bearing"). In the Ili basin, gold is only found in its right affluents, which issue from the syenitic-granite spurs of the Dzungaria Ala-tagh; whilst in the upper waters, or left affluents, which abrade the schistose rocks of the Kara-tagh, there is no gold. Exploring parties of Russian officers, botanists, and others, are being constantly heard of penetrating into China and Thibet, in the hope perhaps of finding the long-sought El Dorado farther eastward.

Mouchketoff's pamphlet, from which is borrowed the sketch-map of the Turkestan gold-fields, may also be consulted.

TURKEY IN ASIA.—The auriferous wealth of ancient Asia Minor is attested by all the old writers.

Herodotus (Bk. vii. c. 28), speaking of the wealth of Pythius, says "and of gold four millions of Daric staters, wanting seven thousand." Rawlinson (iv. 30) in a note gives an account of the value of the different staters, and says the Persian Daric was a gold coin very like the stater; it weighed about 123·7 gr., and was consequently worth not quite 22*s.* (say 1*l.* 1*s.* 10½*d.*). Pythius, therefore, according to the statement of Herodotus, possessed gold coin to the value of 4,339,546*l.* Again (Terpsichore, v. 101), Herodotus mentions "the Pactolus, a stream which, bringing down gold-dust from Tmolus." On this subject, Rawlinson (iii. 301, Bk. v. c. 101) says two small streams descend from Tmolus, one on each side of the ruins of Sardis: "the western, which comes down the broader valley, and passes by the Ionic temple of Cybelê, has generally been considered as the gold-bearing Pactolus (Hamilton's 'Asia Minor,' i. 146–7.)" Like most gold-fields, that of the Pactolus, so celebrated at an early period (Soph. Phil. 393; Strabo, xiii. 897 [c. iv. § 5]), was soon exhausted. By the time of Augustus, it had ceased to produce gold (Strabo, xiii. 897).

Strabo (Bk. xi. c. xiv. § 9, Bohn's edition ii. 271) mentions mines of gold in the Hyspiratis (Groskurd proposes Syspiritis), near Caballa. And (Bk. xiii. c. i. § 23, Bohn ii. 353) says: "In the Troad, above the territory of Abydos, is Astyra, which now belongs to the Abydeni—a city in ruins, but it was formerly an independent place, and had gold-mines, which are now nearly exhausted, like those in Mount Tmolus, near the Pactolus." Also (Bk. xiii. c. iv. § 5, Bohn ii. 403), "The Pactolus flows from the Tmolus [modern Bouz-dagh]. It anciently brought down a large quantity of gold-dust, whence, it is said, the proverbial wealth of Crœsus and his ancestors obtained renown. No gold-dust is found at present."

Ainsworth (1838) found gold disseminated in the sandy matters resulting from the disintegration of diorites in the hills of Khutel, and in the syenitic granite on the banks of the Divrigi river, in the Dumbu-Dagh.

Hamilton (1842) says that in the reign of Justinian, the gold-mines of Trebizond became a subject of dispute between the Greeks and Chosroës I. He gives a long account of the auriferous silver-mines at Gümischkhana [Gumushané], which produce annually 250 to 300 dr. of gold.

Tchihatchef (1864), after quoting Scylax, Herodotus, Sophocles, Virgil, Juvenal, Silvius Italicus, and Seneca, as to the auriferous sands of the Pactolus, and remarking that already in Strabo's time its reputation had declined, explains this apparent exhaustion of the gold by supposing either that the stream which formerly washed the gold from its matrix in Mount Tmolus has dried up, or that its course has been obstructed, and he believes that judicious search would be rewarded.

Farley (1872) remarks that Pliny tells us that, in his time, the riches of ancient Cyprus arose, to a considerable extent, from its copper-mines, the most productive of which were those of Tamasus, in the centre of the island, Soli, on the north coast, and Amathos and Cyrium, on the south. Gold and silver were found in these mines. The mines of Balgar-Dagh, on the slopes of the Taurus, are exceedingly rich, the ores containing 21 per cent. of lead, giving 428 gr. of silver and 4 gr. of gold per 108 oz. The yield at present is trifling, but the mines are capable, under improved management and with good machinery, of producing 12,000 tons annually, while the cost of extraction is estimated at only 24*s.* per ton.

This section may be concluded with the following extract from the report of Consul Wrench for 1880:—

"It may appear a bold prediction to make that this country will become at no distant period noted for its gold-mines; but as it was well known in ancient times as an auriferous region, there is some basis for belief in the possibility of its ancient reputation being revived in this respect. The Messrs. Calvert, who have from the outset been connected with the discovery of mines in Turkey, turned their attention to gold-mines in the Levant many years ago, and have now acquired the most extensive knowledge possessed by any one on the subject. They describe this country as one vast series of auriferous deposits. An analysis of a selected sample of ore, which, to unpractised eyes appears but a poor lead-ore, from one of their mines, by Johnson and Sons, assayers to the Bank of England, gives the following result:—

	Per cent.		Per cent.
Gold	1·23	Sulphur	13·00
Silver	31·27	Carbonate of lime	2·00
Zinc	9·80	Oxygen, &c.	3·50
Lead	(?) 11·10	Silica	25·20
Copper	0·50		
Oxide of iron	2·40	Total	100·00

"The yield of the ore per ton, should this sample prove an average one, is therefore :—

	£	s.	d.
Gold, 401 oz. 16 dwt., at 4*l.*	1,607	4	0
Silver, 10,214 oz. 17 dwt., at 4*s.* 6*d.*	2,298	6	10
Total	£3,905	10	10

"And in other places, ores of the same class, some of them associated with tellurium, have been met with, worth 2000*l.* to 6500*l.* per ton. Hitherto but one concession for an argentiferous gold-mine in Turkey has been granted, and the Calverts, as discoverers, are the concessionnaires. This mine is situated near Serdjiller, about 12 miles from the Dardanelles, and it is no doubt that of Astyra, which the ancients said was worked by King Priam of Troy. In company with Calvert and W. L. Stoney, C.E., I visited this mine, and a brief description of what I observed may be interesting.

"The Serdjiller gold-mine consists of a quartz reef 40 to 60 ft. wide, projecting several ft. above the surface, like a wall, for nearly half a mile in length, and extending from the summit of a mountain of mica-schist and syenite 1500 ft. high, right down its side to the valley below. There are several ancient galleries in this reef. From the top of the reef near the summit, I struck off some pieces of quartz, which, though not a particle of the precious metal was visible to the naked eye, on being assayed in London by Claudet, assayer to the Bank of England, proved to be of the remarkable richness of 8 oz. 3 dwt. 10 gr. of gold per ton of ore. On the summit are the ruins called Kalé-Tath (Castle Stone), so called from a prehistoric fortress constructed of rough blocks of quartz. Another sample from this mine proved on assay by Johnson and Sons to be still richer, for the yield was 43 oz. 10 dwt. of gold per ton of ore. Other samples ranged from 1 oz. 13 dwt. down to 19 dwt. 10 gr. of gold per ton of ore, together with a nearly equal quantity of silver, and the reef appears auriferous throughout.

"Stoney was much struck with the size and richness of the reef, and he attaches great value to this mine, not only on that account, but from the unusual facilities for working, as it can be commenced as an open quarry with a natural drainage, and an inclined plane for lowering the ore to the base of the hills, where water-power is available for crushing; and also from its proximity to a seaport, to which a good level road leads. The property is about 1000 acres in extent. The quartz reef cropping out at the surface is found to increase to 100 ft. in width in the ancient galleries. Besides this one, I understand that further exploration has resulted in establishing the fact that other quartz reefs converge, towards Kalé-Tath, from different parts of the mountain.

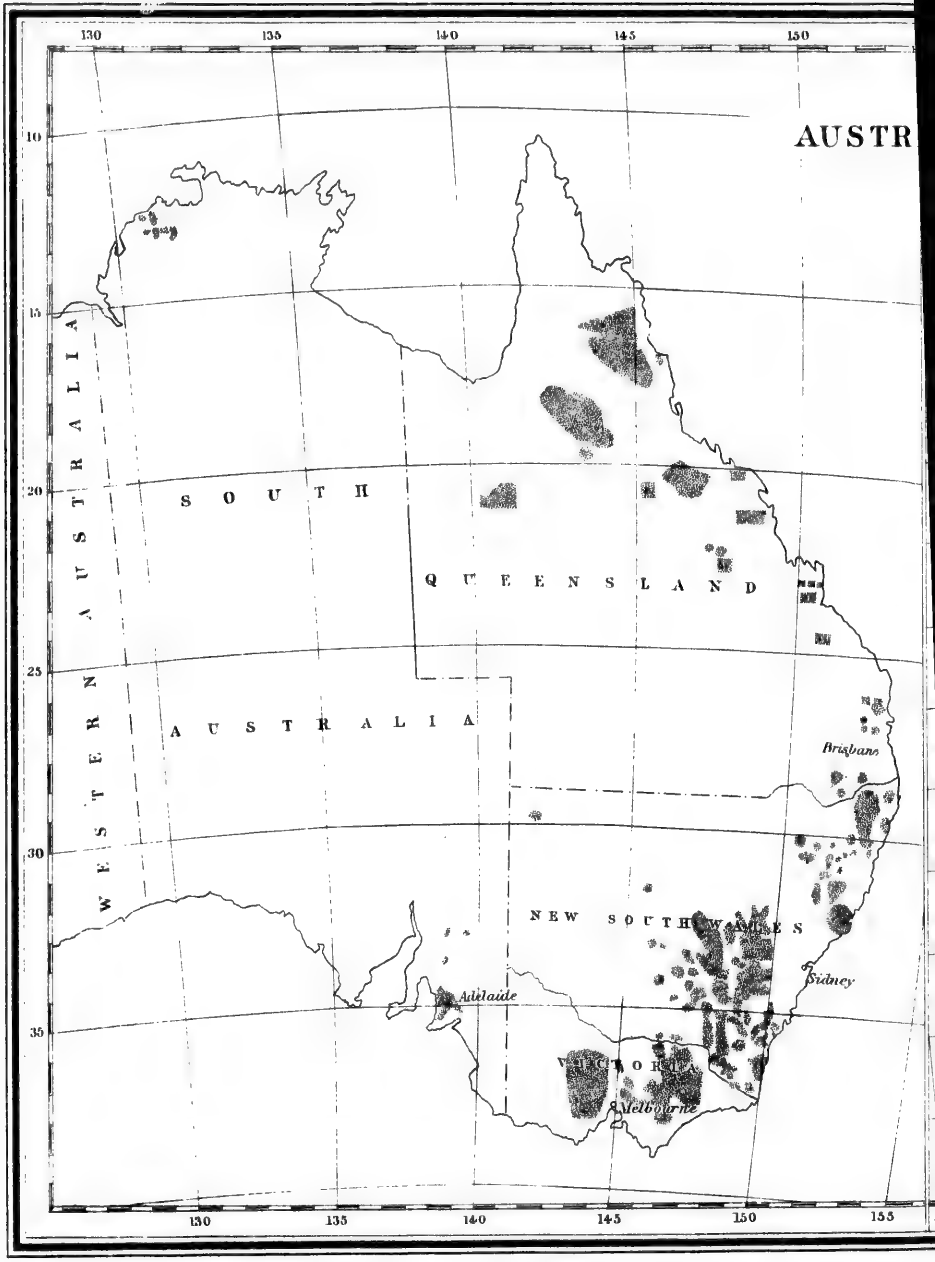
"It is highly desirable that the mining regulations of Turkey be revised, and the formalities simplified, for at present they are extremely vexatious, and open the door to corruption and abuses, to the detriment of those who have honestly acquired mining rights. If mining "claims" and rights were as properly defined and placed on the same footing as all other rights of real property, it would be a step in the right direction; for in respect of real property, original official title-deeds are delivered without delay, whereas in the case of mining rights, pending the grant of a firman of concession—a tedious process lasting through several years—the only original official documents delivered consist of a "prospecting" licence, and a receipt for the application for concession; neither of which is procurable until after many formalities, and a long lapse of time, and which after all do not by any means constitute as satisfactory a security for the holder as the original official title-deeds delivered for other descriptions of real property. The discoverer of a mine is often deprived of his rights by designing persons, and this because there is no provision in the mining law for the protection of his title by official certificate."

AUSTRALASIA.

The quantity of gold raised in the Australasian colonies since 1851 is shown in the following table:—

Colony.	Prior to 1878.		During 1878.		Total.	
	Estimated Quantity.	Value.	Estimated Quantity.	Value.	Estimated Quantity.	Value.
	oz.	£	oz.	£	oz.	£
Victoria	47,283,377	189,133,508	775,272	3,101,088	48,058,649	192,234,596
New South Wales ..	8,693,368	32,193,191	117,978	423,184	8,811,346	32,616,375
Queensland	2,617,500	9,675,419	283,592	1,052,490	2,901,092	10,727,909
South Australia ..	46,356	184,767	10,747	42,650	57,103	227,417
Total of Australia	58,640,601	231,186,885	1,187,589	4,619,412	59,828,190	235,806,297
Tasmania	45,751	180,600	25,249	100,000	71,000	280 600
New Zealand	8,648,996	33,765,194	310,486	1,240,079	8,959,482	35,005,273
Total of Australasia	67,335,348	265,132,679	1,523,324	5,959,491	68,858,672	271,092,170

NEW CALEDONIA.—The most detailed account of gold in New Caledonia is given by Heurteau (1876). The first discovery of gold was made in 1863, in the eastern slope of the mica-schist range bordering the N.E. coast of the island, in the Poëbo country. In the end of 1870, four miners, exploring the valley of the Diahot, encountered rich outcrops in the Manghine hill on the left bank, for which they obtained a concession.



AUSTR
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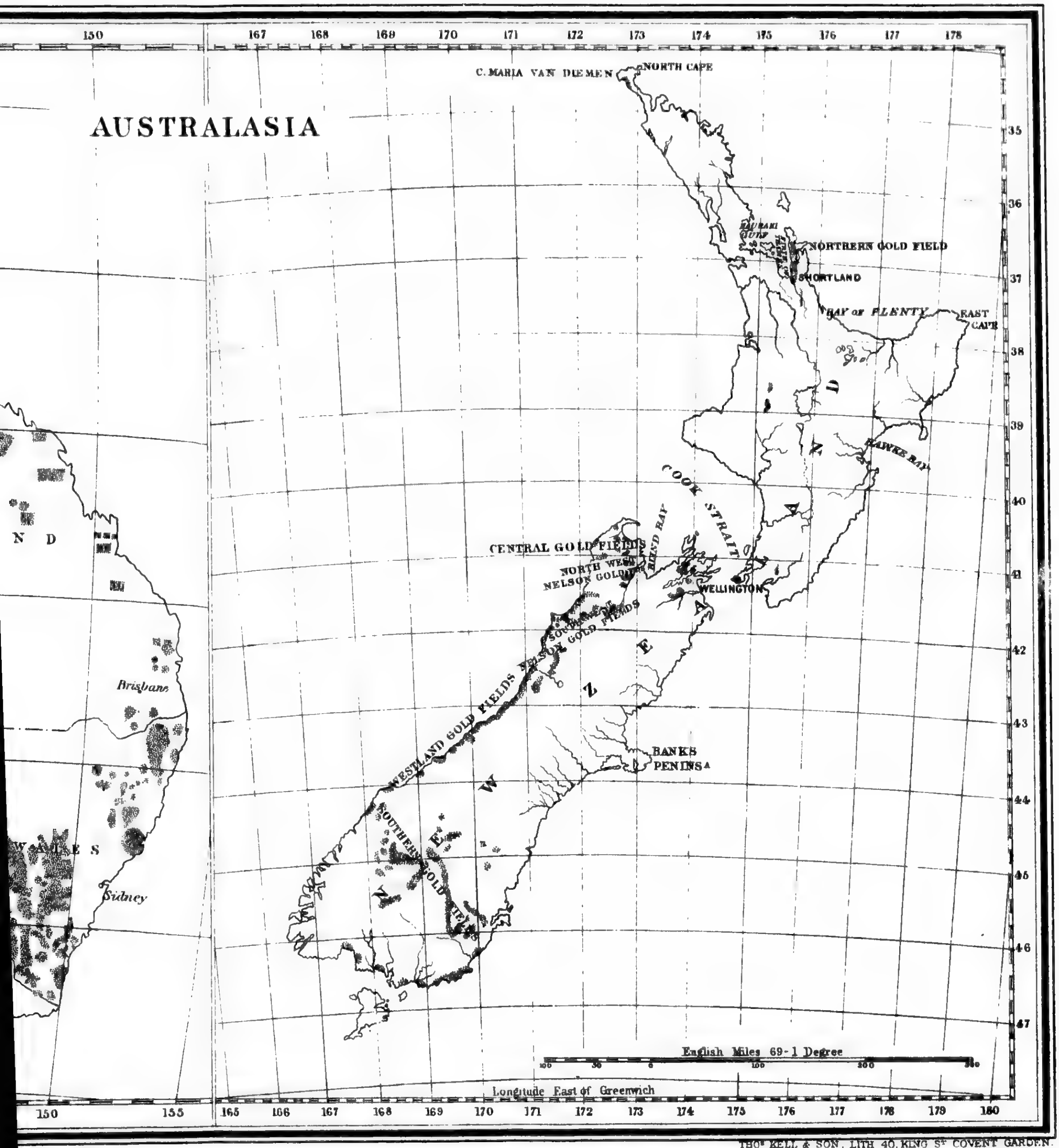
WESTERN AUSTRALIA
SOUTH AUSTRALIA
QUEENSLAND
NEW SOUTH WALES
VICTORIA
Brisbane
Sidney
Adelaide
Melbourne



THOS KELL & SON, LITH 40, KING ST COVENT GARDEN.

This remains the only payable auriferous ground yet discovered, though colours have been got in the streams flowing from the mica-schist range to the sea, in the Pouebo and Oubatche countries. The concession, known as Fern Hill, had yielded to the month of September, 1873, 1200 tons of quartz, from which had been extracted 4663 oz. of gold, valued at 17,756*l*. The vein strikes N. 25° E., dips vertically, and varies in width from 15 in. to 5 ft. It consists of a number of thin veins of quartz traversing a schistose mass. Various other outcrops of copper-ores containing some gold are met with, but not of sufficient importance to be considered gold-ores. The gold occurs native in grains in the quartz, and disseminated through the neighbouring schist. The metal contains 7½ per cent of silver. In working, it has been found that the free gold disappears in depth, and the vein-stuff becomes a mixture of common and magnetic iron-pyrites, so poorly auriferous that the workings have been suspended.

G. Milner Stephen (1872) writes to Sir R. Murchison that gold has been discovered on the banks of the river Bondé, on the N.E. coast of New Caledonia; 2½ tons of the auriferous drift were brought to Sydney, and found to be highly charged with very fine, almost invisible gold-dust, to an extent of 16 oz. to the ton.

The exports from Noumea were 53½ oz. in the last quarter of 1879.

New Guinea.—A report by C. S. Wilkinson on auriferous specimens from New Guinea was published in the annual report of the Department of Mines, New South Wales, for the year 1878, from which the following information is extracted.

The discovery of gold by the Rev. Mr. Lawes and Andrew Goldie was in confirmation of what had been anticipated from an examination of the rock specimens already obtained from New Guinea by the Hon. W. Macleay, during his voyage of exploration in the *Chevert*, and by D'Albertis on the Fly river. Some of the specimens in Macleay's collection were described by Wilkinson in a paper read before the Linnæan Society of New South Wales on the 28th February, 1876; but he purposely refrained from making allusion to the probable occurrence of gold-bearing deposits in New Guinea, lest miners might be induced to rush to that inhospitable country, where at present the lives of Europeans would, from well-known causes, be greatly endangered.

For the same reason, he was also silent regarding the geological indications of gold-bearing formations, as shown by the collection of rocks obtained by D'Albertis on the Fly river. Amongst these specimens were stone tomahawks formed from altered sandstone (probably Silurian) and greenstone or diorite, containing in some instances iron-pyrites. This greenstone, in association with the Silurian and Devonian beds, is the main source of the auriferous deposits on some of the principal gold-fields in New South Wales, and it is therefore suggestive of the occurrence of gold in New Guinea. At the same time there is no reason to expect that richer deposits will be found there than are indicated by the auriferous formations in New South Wales, where is such a vast tract of known gold-bearing country open for profitable mining enterprise. This fact is worth the careful consideration of those intending gold-seekers who may be fascinated by the distant prospect, and to whom Lawes has given earnest and timely warning against rashly proceeding to Port Moresby, where he is "quite sure great misery and loss of life must ensue if there is any influx of Europeans during the wet season."

The samples of quartz and auriferous black sand, sent from New Guinea by Goldie, and submitted for examination by Mason Bros., of Pitt Street, are as follows:—

The black sand consisted almost entirely of small crystalline grains of magnetic oxide of iron and specular iron, with a few small pebbles of limonite, brown oxide of iron, and numerous prismatic and octahedral crystals of zircon, the edges of the crystals not being in the least degree waterworn. There were also a few scales of yellow mica and a little quartz sand.

The sample weighed 7¾ oz., and yielded 5·75 gr. of gold. But this yield affords no certain evidence of the richness of the actual wash-dirt, in the absence of any information as to the number of dishes or quantity of dirt from which Goldie washed this sample of auriferous sand. The gold is light and scaly, and some of it as fine as dust.

The quartz consisted of broken pieces of very waterworn pebbles or boulders, and showed freely small masses of pale yellow mundic or iron-pyrites, but no gold to the naked eye. It, however, yielded on assay at the rate of only 2 dwt. of gold and silver to the ton, the gold being in excess of the silver.

The few but interesting specimens obtained by Lawes give an insight into the geological character of the country lying E. of Redscar Bay and Port Moresby. The fragments of slate sandstone, quartz, greenstone, and jasperoid rocks, indistinguishable from specimens of the Silurian series from some of the gold-fields of New South Wales, lead to the inference that the lofty Mount Owen Stanley, Mount Astrolabe, and intervening ranges, are to a great extent, if not wholly, composed of these rocks, and are gold-bearing. The auriferous character of this part of New Guinea was suspected by Wilkinson after examining in 1876 the rock samples collected by Hon. Wm. Macleay from Hall's Sound. But there is now evidence of the actual discovery of gold by Lawes in the Kupaloloko river, and by Goldie in the Goldie river. One of the samples, from the bed of the Kupaloloko, near Mount Vetura, which contained much magnetic iron-sand, gave an average assay of 3 dwt. of gold per ton, the sample having been subjected to no washing or other reduction in bulk, and representing the mass as it occurred. The Kupaloloko runs parallel with the Goldie farther E.; both discharge into the Laloke river. There is nothing to warrant the belief that the deposits are richer than is ordinarily the case in New South Wales.

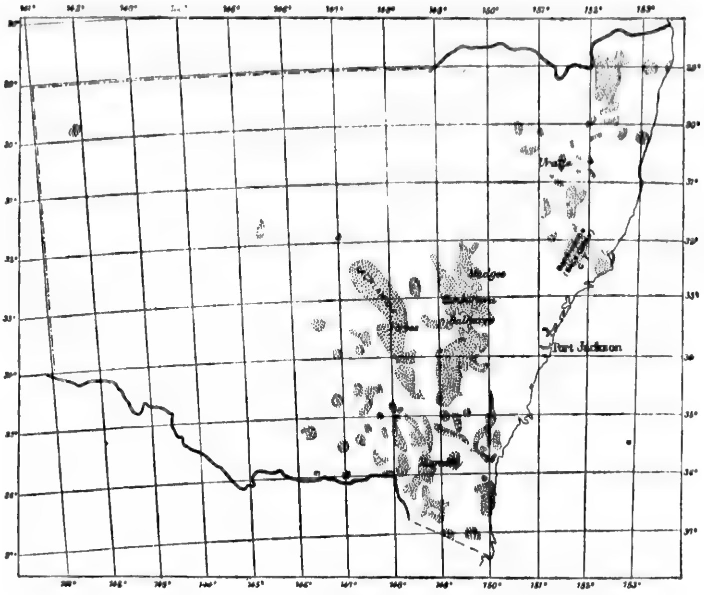
On the S. side of Fairfax Harbour, from the hill under which the *Basilisk* lay, a considerable quantity of gold-quartz was taken by Capt. Moresby's party in 1874; and at Pitt Bay, at the E. end of Moresby Island, one piece of auriferous quartz was got from the bed of a stream, but a second could not be found.

NEW SOUTH WALES.—New South Wales abounds in minerals. According to competent authorities, the auriferous districts of this colony are far larger than those of any other in Australia, and as rich as the richest, if not more so. Up to 1871, only alluvial washings were carried on, and the wealth lying in quartz reefs was comparatively neglected. There were then upwards of 16,000 miners engaged. Since the veins have been worked and quartz-mining has come into operation, there has been an extension in this direction, and the results have, in a few instances, been unexpectedly rich. The Emu Creek gold-field alone sent by escort to Sydney, from October, 1866, to September, 1871, 182,061 oz. of gold. From 2 mines on Hawkins' Hill, the yield in 6 months was gold to the value of 162,850*l.*, after paying escort fees and mint charges.

The proclaimed gold-fields extend with short intervals the entire length of the colony, with a breadth of 200 miles. It is highly probable that rich and extensive gold-fields will be discovered for many years to come. There are immense tracts in the interior which have not yet been prospected. In many miles of country, the rocks that belong to a golden area yet remain in their original condition, and will so remain till some fortunate adventurer stumbles by accident on a tangible encouragement.

All the great gold-fields of the west are within 2 days' journey of the capital, and there is not any mining settlement which may not be easily reached. The gold-mining centres present the appearance of orderly and thriving townships, with schools, churches, journals, shops, and places of amusement. The authority to dig or mine for gold is given to all who apply for it. It costs only 10*s.* a year, and entitles its possessor to take up ground upon any gold-field to the extent of 60 ft. by 60 ft. to 114 ft. by 114 ft., according to the class of mining pursued upon the particular field. If a man wants to open a quartz mine, he can take up 50 ft. along the line of reef, with a breadth of 100 yd. on each side. His miner's right also entitles him to occupy ½ acre of land for his dwelling, and to an electoral vote. A man may take up as many claims as he likes, if he will work them. Sluicing claims extend to 10 acres.

FIG. 19.



SKETCH-MAP OF NEW SOUTH WALES GOLD-FIELDS.

The yield of gold in New South Wales is thus stated by Reid for the years 1851–1875 :—

Year.	£
1851–55	6,338,257
1856–60	5,192,326
1861–65	8,606,291
1866–70	5,069,802
1871–75	6,207,265
Total	£31,413,941 or 8,436,114·5 oz.

Year.	oz.	£	s.	d.
1871	323,609·79	1,250,484	15	11
1872	425,129·71	1,643,581	16	11
1873	361,784·71	1,395,175	8	7
1874	270,823·31	1,040,328	13	6
1875	230,882·50	877,693	18	0

The quantity of gold won in 1877 is stated at 121,923 oz. 12 dwt. 15 gr., value 456,973*l.* 13*s.* 10*d.*

The statistics of the gold-exports for 1869–1878 are thus given by the Registrar-General:—

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	oz.	£		oz.	£
1869 ..	642,358	2,493,869	1874 ..	482,076	1,875,081
1870 ..	410,547	1,585,736	1875 ..	552,592	2,097,740
1871 ..	535,492	2,074,937	1876 ..	410,330	1,589,854
1872 ..	543,430	2,111,231	1877 ..	468,518	1,824,188
1873 ..	665,676	2,590,145	1878 ..	436,766	1,699,953

The official statistics of the gold-exports for 1864–1879 are:—

		1864.	1865.	1866.	1867.	1868.	1869.*	1870.*	1871.*
Gold:									
Coin	Boxes	553	512	634	453	414	500	296	401
	£	2,647,516	2,325,844	2,815,437	2,041,383	1,771,005	2,184,612	1,206,569	1,724,088
Dust and Bar	Oz.	78,169	115,126	134,659	136,348	98,668	149,095	178,513	156,382
	£	304,955	441,006	531,983	544,661	382,616	578,260	672,254	601,250

		1872.*	1873.*	1874.*	1875.*	1876.*	1877.†	1878.†	1879.†
Gold:									
Coin	Boxes	387	490	397	461	370	418	400	214
	£	1,656,131	2,151,168	1,719,888	2,082,591	1,575,876	1,816,495	1,653,911	695,303
Dust and Bar	Oz.	186,730	200,134	58,231	3,102	19,178	12,696	36,059	5,589
	£	731,120	773,439	222,194	11,914	76,84?	51,940	138,620	22,840

* Exclusive of exports overland, amounting to 2,355,718*l.* in 1869, 2,137,273*l.* in 1870, 3,460,266*l.* in 1871, 2,441,478*l.* in 1872, not stated in 1873, 3,388,231*l.* in 1874, 4,217,912*l.* in 1875, and 3,957,980*l.* in 1876.

† Inclusive of exports overland, amounting to 3,742,780*l.* in 1877, 3,677,122*l.* in 1878, and 4,103,935*l.* in 1879.

The quantity and value of gold raised at New South Wales prior to 1st January, 1881, with approximate area of the deposits, and the formations in which they chiefly occur are thus given:—

Quantity.	Value.	Approximate Area.	Formations in which chiefly found.
oz.	£	Square miles.	
9,075,552·45	33,777,344	35,500	Cainozoic, Palæozoic, Granite, Porphyry, Serpentine, Diorite.

The following table shows the quantity and proportion of gold obtained from certain parcels of wash-dirt, puddled, sluiced, &c., during the year 1880, as ascertained by the wardens of the gold-fields:—

District.	Quantity.	Average yield of Gold per ton.			Total yield of Gold.		
	tons.	oz.	dwt.	gr.	oz.	dwt.	gr.
Bathurst	21,361	0	3	18·74	4,038	8	0
Mudgee	3,090	0	6	16·00	1,030	0	0
Lachlan	33,443	0	5	3·82	8,626	19	8
Southern	230,790	0	0	4·34	2,091	0	12
Peel and Uralla ..	3,500	0	2	18·85	487	10	0
	292,184	0	1	2·73	16,273	17	20

Annexed are similar details concerning parcels of quartz :—

District.	Quartz crushed.			Average yield of Gold per ton.			Total yield of Gold.		
	tons	cwt.	qr.	oz.	dwt.	gr.	oz.	dwt.	gr.
Bathurst	5,811	0	0	0	5	11·99	1,597	18	7
Tambaroora and Turon ..	4,183	10	0	0	15	6·72	3,196	4	13
Mudgee	2,420	0	0	0	9	17·25	1,176	0	0
Lachlan	3,023	10	0	0	12	12·28	1,892	15	0
Southern	2,102	0	0	1	0	0·28	2,103	5	0
Tumut and Adelong	2,528	10	0	1	4	4·13	3,055	19	18
Peel and Uralla	2,447	0	0	0	17	1·85	2,089	8	0
New England and Clarence ..	66	5	0	7	3	10·23	475	2	0
Hunter and Macleay	2,082	15	0	1	15	21·88	3,813	7	19
	24,664	10	0	0	15	17·54	19,400	0	9

The summary on p. 483, compiled from mining registrars' reports, shows approximately the number of miners employed in gold-mining, the quantity of gold won, the area of ground worked, and the value of machinery, in New South Wales, during 1880.

The table on p. 484 shows the width, dip, and strike of quartz reefs in some of the deepest mines in the colony, being worked during 1880, and the average yield of gold per ton.

A clear and succinct view of the present condition of the gold-industry of New South Wales may be gained from the following summary of the last (1881) reports furnished by the Wardens and Mining Registrars. The chief fields will be separately described afterwards.

Scarcity of water has been experienced in the Bathurst, Tambaroora and Turon, Lachlan, Mudgee, Southern, and Peel and Uralla districts. From most of the older gold-fields, a large proportion of the miners were drawn away by the discovery of gold at Temora and at Montreal, and the same thing is now happening with regard to the recent discovery of gold at Mount Browne, in the extreme N.W. corner of the colony. These discoveries are doubtless beneficial in the long run, but their immediate effect is frequently a reduction in the output of gold. This has been in a marked degree the effect of the rush to the Temora gold-field, because many miners abandoned claims that were yielding a moderate return, on some of the older gold-fields; and, owing to the scarcity of water at Temora, even those whose claims contain payable deposits have not been able to reap the reward of their enterprise and industry. Fortunately the coarse character of the gold has enabled some of the claimholders to extract a comparatively large quantity of gold without washing; but had a plentiful supply of water been available, there can be no doubt, not only that Temora would by this time have proved a rich and extensive gold-field, but the quantity of gold realized

District and Division.	Alluvial-miners.		Quartz-miners.		Total Miners.	Quantity of Gold.			Price of Gold per oz.		Value of Gold won.	Alluvial Ground worked.	Quartz Reefs proved to be auriferous.	Value of Machinery.
	Europeans.	Chinese.	Europeans.	Chinese.		Alluvial.	Quartz.	Total.	From	To				
	No.	No.	No.	No.	No.	oz. dwt. gr.	oz. dwt. gr.	oz. dwt. gr.	s.	s.	£ s. d.	Square miles.	No.	£
Bathurst district ..	283	121	258	10	672	4,410 8 18	6,595 19 19	11,006 8 13	50/	79/	40,710 3 3	190	17	16,260
Tambaroora and Turon district ..	370	252	325	178	1,125	5,105 9 18	8,840 10 1	13,945 19 19	74/	76/3	52,341 0 10	135	35	62,599
Mudgee district ..	1,055	302	29	..	1,386	18,895 8 16	1,196 19 15	20,092 8 7	72/	78/6	77,409 3 11	370	22	9,910
Lachlan ,, ..	5,646	29	317	..	5,992	15,327 2 17	3,231 1 15	18,558 4 8	70/	77/6	67,111 4 6	153	63	20,510
Southern ,, ..	1,222	475	143	..	1,840	17,168 15 12	2,169 5 0	19,338 0 12	66/	80/	72,739 19 7	48½	40	40,145
Tumut and Adelong district ..	591	211	404	..	1,206	16,465 3 3	1,810 18 7	18,276 1 10	70/	80/	72,429 11 11	140	114	138,840
Peel and Uralla district	406	182	105	..	693	4,731 13 9	2,358 3 14	7,089 16 23	70/	75/6	25,968 0 8	30	5	6,200
New England and Clarence district	181	31	13	..	225	2,953 2 0	265 15 14	3,218 17 14	50/	77/	11,038 0 8	328	85	15,800
Hunter and Macleay district ..	40	..	214	..	254	639 9 22	8,805 18 2	9,445 8 0	59/	75/	31,837 17 6	..	51	11,000
Not within a mining district	52	..	..	..	52	103 4 15	..	103 4 15	70/	75/	366 8 8	..	..	..
	9,846	1,603	1,808	188	13,445	85,799 18 10	35,274 11 15	121,074 10 1	50/0	80/0	451,951 11 6	1,394½	432	321,264

District.	Division.	Name of Company.	Name of Reef.	Depth at which Quartz was got.	Quantity crushed.	Average yield of Gold per ton.	Width of Reef.	Dip.	Strike.
				ft.		oz. dwt. gr.			
Tambaroora and Turon.	Hill End	Star of Peace	Hawkins' Hill	750	1100 tons	0 10 0	..	..	..
		Krohmann's A. G. M. Co.	Ditto	713	281 ,,	2 7 0	..	..	..
		New Caledonian	Ditto	375	730 ,,	0 4 0	..	..	..
		Patriarch	Ditto	480	224 ,,	0 10 17	..	..	..
		Ditto	Ditto	250	70 ,,	3 1 0	..	..	..
Bathurst	Bathurst	Independent Co-operative Co.	Napoleon Reef	100	30 ,,	0 6 16	..	..	..
		Ditto	Mosquito Reef	90	17 ,,	0 1 4	..	..	..
		Ditto	Flat Reef	100	68 ,,	0 2 2	..	..	..
	Tuena	Victoria Co.	..	200	150 ,,	0 10 4	..	..	..
		Washington Reef	Washington	180	100 ,,	0 10 0	..	..	..
	Carcoar	Never Budge	The Forest	100	800 ,,	0 6 10	..	..	..
	Mitchell's Creek	Grabham and McCarthy	Dark Corner	30	49 ,,	1 0 0	2 ft.	..	N.—S.
		Robert Smith and party	Ditto	50	100 ,,	0 13 3	1 to 1 ft. 6 in.	..	..
Mudgee	Wellington	Mitchell's Creek	Lincoln	360	1415 ,,	0 12 0	2 ft.	E.	N.
		Kaiser	Mitchell's Creek	100	1155 ,,	0 6 0	..	..	..
Lachlan	Parkes	Talbot, Medlyn, and party	Bonnie Dundee	174	38 oz.	19 10 0	3 ft.	S.W.	..
		Dayspring	Currajong Reef	105	74 tons	0 15 0	..	..	..
		Duggan and Co.	Ditto	96	15 ,,	[illegible] 15 5	..	..	..
		Little Wonder	Parkes	96	26 ,,	0 11 0	..	..	..
			Bonnie Dundee	175	638 ,,	0 10 5	..	..	..
			Ditto, No. 2	145	62 ,,	0 19 16	..	..	..
	Grenfell	Campbell and party	Homeward Bound	240	322 ,,	0 16 0	..	..	..
		Mitchell and party	Ditto	240	189 ,,	0 6 0	..	..	..
		Pritchard and party	Outward Bound	80	36 ,,	0 3 0	..	..	..
		Pettit and party	Enterprise	170	120 ,,	1 8 0	..	..	..
		O'Brien's G. M. C.	O'Brien's Lease	100	200 ,,	0 7 6	..	..	..
		Consols Lease, sundry parties	O'Brien's Hill	210	300 ,,	0 10 0	..	..	..
Southern	Major's Creek	Big Hill Co.	Big Hill	184	300 ,,	0 2 0	..	..	..
	Nowra	Eureka	Dangera Creek	250	70 ,,	0 1 2	..	..	..
		Homeward Bound	Ditto	400	80 ,,	1 1 0	..	..	..
		Pinnacle	Ditto	175	218 ,,	1 9 8	..	..	..
		Keiller's	Ditto	150	16 ,,	0 15 0	..	..	..
Tumut and Adelong.	Adelong	Perseverance G. M. C.	Old Line of Reef	840	796 ,,	0 1 6	5 in.	..	10° N.
		North Caledonian	Williamstown	300	78 ,,	1 18 0	6 ,,	..	..
		Union G. M. C.	Victoria Reef	428	73 ,,	0 19 0	1 to 6 ft.	E.	N.—S.
		Challenger	Adelong	600	793 ,,	0 16 15	..	..	..
		Trudgeon and party	Caledonian	220	44 ,,	1 4 0	8 in.	..	N.—S
	Tumbarumba	Peep O'Day	Ournie	180	208 ,,	1 15 0	..	..	..
Peel and Uralla	Nundle	J. B. Robertson and party	Opossum	250	500 ,,	0 10 0	10 in.	E.	N.—S.
		Ditto	Foley's	230	10 ,,	1 0 0	9 ,,	..	,,
		T. Bakewell and party	Brown Snake	160	100 ,,	1 0 0	6 ,,	N.E.	N.W.—S.E.
		J. Stanning	Foley's Folly	200	25 ,,	0 17 0	6 ,,	W.	N.—S.
		Wheal Prosper Co.	Ditto	500	40 ,,	0 18 0	6 ,,	,,	,,
New England and Clarence.	Solferino	Private Miners	Garibaldi	70	1¼ ,,	61 6 16	9 ,,	..	..
		Ditto	Ditto	70	¼ ,,	220 0 0	9 ,,	..	..
Hunter and Macleay.	Bulladelah	Curreki	Coolongolook	95	147 ,,	1 18 2	..	..	..
		Sterling	Ditto	75	25 ,,	1 2 10	..	..	..

from the earth raised during the year would have more than compensated for the reduced yield consequent upon the abandonment of claims on the older fields. The quantity of wash-dirt stacked ready for washing as soon as water is obtained is estimated by the Warden at 65,000 loads, and by the Mining Registrar at 50,113 loads, calculated to contain 30,010 oz. of gold. There are 97 payable claims on the field, and the quartz reefs which have not yet been much worked show some very rich stone—one line is 2 ft. wide, and one 4 ft., but there is no machinery on the ground.

As regards the discovery of gold at Montreal, close to the sea-coast, and on the S.E. side of the Dromedary mountain, Warden Keightley says—"The field contains a rich deposit of free gold which has been subject to the action of the sea, reducing it to a water-worn condition, but evidently washed back by the sea and ranged in two terraces about high-water level. . . . Experience has shown that ground considered valueless during the rush is now being proved highly auriferous, and the run has been traced to the west through terraces, and is now being found under lake Wallaga." He has not yet succeeded in tracing any connection between this deposit and that at the Gulf gold-field, or that on Mount Dromedary. He says there are now over 30 claims on payable gold, some half-dozen exceedingly rich, producing from several dwt. to over 3 lb. weight of clean gold to the dish; 8 ordinary buckets of wash tested, taken off the bed-rock, gave the handsome yield of 7 lb. 7 oz. of gold.

At Corunna, 14 miles N. of Montreal, similar deposits of black sand containing gold have been found; also at Wagonga; while S. of Montreal, at a place called Nelson, gold is being found in payable quantities, but of a coarser description.

A shaft has been sunk by means of water-tight boxes in Wallaga lake, about 150 ft. from the margin. The shaft was bottomed at about 28 ft. on payable gold. At the Wantiol rush, near Junee, some 600 miners are on the ground; but no rich finds have yet been reported. The rush to Mount Werong did not produce very satisfactory results; but this was due to want of a more extensive search, especially under the basalt. In the Carcoar district, some very promising reefs have during the year been discovered and worked at Milburn Creek; the reefs so far as opened up are said to show rich stone throughout. On Crudine Creek, in the Tambaroora and Turon district, some sluicing ground has been opened, and a large extent is likely to prove payable. At Upper Bingera, in the Peel and Uralla district, some rich ground has been opened on the wet lead. One party is said to have realized 20*l.* per man per week for several weeks.

On the older gold-fields very satisfactory progress has been made during the year, allowance being made for the effects of the drought and the rushes to new fields. The Warden at Carcoar reports that the Brown's Creek Co., one of the most important in the colony, treated 20,531 tons for an average of 3 dwt. 1¾ gr. per ton, being a higher average than was obtained in 1878 or 1879. He also reports that a company was formed to work a large reef on the Belubula river by water-power—1294 tons yielded 3 dwt. per ton,—and states that there are several localities on the banks of the river where large but comparatively poor reefs could be advantageously worked by water-power. The Mining Registrar reports the finding of rich quartz at Caloola.

The Warden at Copeland calls attention to the large reefs at Cobark, which he says average ½ oz. per ton, are easily worked, and the stone could, by means of an adit, be inexpensively conveyed to a battery, and he adds that a battery of 30 heads could be worked by water-power. In his opinion (and his experience is very extensive), this locality and the Kerriput present excellent openings for the investment of capital under good management. He reports that many of the mines at Copeland are idle: this is probably due to the rush to newer fields, as there can be no doubt that the reefs in this locality would pay well if properly worked, and it is scarcely likely that they will be allowed to remain long unworked. The return furnished by the Mining Registrar at Copeland shows that the stone raised during 1880, so far as the results can be obtained, averaged 2 oz. 1 dwt. per ton, or less by 1642 oz. than for 1879; but the decrease in the number of miners is so much greater that the average yield per miner is greater in 1880 than in 1879. At one claim there were 400 tons of quartz at grass at the end of the year which could not be crushed for want of water. The machinery on the field has increased and improved, though there are localities entirely without machinery, which cannot be developed for want of it. The Warden also reports that the reefs at Little River, Dungog, have given good returns.

The Warden at Braidwood reports that the attempt to extract the gold from the pyritous veins at Major's Creek has resulted in failure, notwithstanding the large outlay of capital. This is deeply to be regretted, as these veins have been proved to contain a large quantity of gold. So far the only process by which the gold can be extracted from these veins is a chlorine process in use in Victoria; but the cost of carriage of the material to the works is so great that the margin left barely covers the cost of raising the stone. There appears to be a prospect of the quartz reefs at Little River, in the Braidwood district, being efficiently worked.

The Mining Registrar at Orange reports that the pyritous reefs at Lucknow, near Orange, are proving richer, wider, and more permanent at 385 ft. than near the surface; but the material has to be sent to

England for treatment. Pyrites sent by the Reform Co. to England for sale during the last 9 months of the year realized 4149*l.* The Mining Registrar at Araluen says the reefs there have been proved to contain gold in payable quantities; but, owing to a mixture of base metals, it cannot be extracted by any process known in the district. At Yalwal, in the Shoalhaven district, though the quartz reefs cover a wide extent of country, prospecting is confined to a very small area. The reefs at work appear to give good returns. The quartz at the Eclipse mine is said to yield 1½ to 4½ oz. per ton; at the Pinnacle mine, the average is 1½ oz. per ton; at the Pioneer, with a reef averaging 6 ft. wide, the yield per ton is 19 dwt. 18 gr.; at the Homeward Bound, the average is 1 oz. per ton.

The extensive works in course of construction for the purpose of bringing water to hydraulic the numerous dykes of granite containing payable gold at Poverty Point, in the Clarence district, are not yet completed; but the Warden says that when complete, a large yield of gold may be anticipated, as the water will have a pressure of 50 ft.—quite sufficient to break down and reduce the soft granite, an almost unlimited extent of which is known to be auriferous. If this undertaking prove successful, there is a probability that the similar deposit at Wilson's Downfall, referred to by Geological Surveyor Pittman, will also be worked.

In the Cobar district, reefs have been opened up at Tindayrie and at Honeybogle, which promise to prove payable; but work has been suspended at the latter place, in consequence of a dispute as to the ownership of the land. Prospecting is said to be carried on with success at Rock Holes, in the same district.

Warden Browne, of the Mudgee district, and who has recently been removed to Dubbo, in submitting his last report, points out that nearly a score of tons of gold have been won with rude appliances, chiefly from alluvial deposits, within the comparatively small area worked, and that it is scarcely likely that the whole district, comprising several hundred square miles, has been completely denuded of the precious metal. From his report, it appears that prospecting has been retarded by the drought; but some deep claims at Home Rule, which are paying well, have established the existence of a defined lead trending in the direction of the Britannia lead, and thence probably making for the main channel or gutter formed by the junction of the Star and Black leads. He also reports fair progress by the prospectors on the Black lead, and expresses an opinion that much payable ground might be opened at the Canadian, if powerful steam machinery were employed to drain the lower levels; he likewise reports the erection of machinery to work on a large scale the extensive deposits of cement at Tallawang; and further, the discovery of payable gold on the private property of the Hon. G. H. Cox, on the S. bank of the Cudgegong and at Bara Creek, and indications of payable gold being found in an extensive flat within the Havilah estate.

The Mining Registrar at Windeyer reports the finding of nuggets varying from 5 to 11 oz. on the Upper Meroo.

The following table, furnished by the Master of the Mint, shows the quantities of gold brought by escort and otherwise into the Royal Mint at Sydney during the years 1879 and 1880:—

District.	1879.	1880.
	oz.	oz.
Bathurst	10,141·22	15,025·76
Tambaroora and Turon	15,365·25	12,392·30
Mudgee	17,879·82	15,837·84
Lachlan	6,457·79	8,661·14
Southern	8,361·04	12,649·33
Tumut and Adelong	13,582·38	16,245·34
Peel and Uralla	3,305·17	3,676·64
New England and Clarence	..	1,188·00
Hunter and Macleay	8,853·49	8,667·00
Not within a Mining District	..	1,101·48
Localities unknown	22,953·72	21,224·69
	106,899·88	116,669·52

The following table, furnished by the Collector of Customs, shows the quantity or estimated quantity and the value of the gold exported during the year 1880:—

Dust.		Auriferous Quartz.		Total.	
Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
oz. 81	£ 304	pkgs. 185 2513 cwt. pyrites.	£ 6902	oz. 1931	£ 7206

Hitherto, the returns so furnished have been deemed the most reliable sources from which to ascertain the quantity of gold won in the colony, and, in the absence of complete returns from all the mines in the colony, these tables taken together perhaps still furnish the most reliable information on the subject, though it may fairly be assumed that since the export-duty on gold has been removed, all the gold sent out of the colony is not recorded at the Custom House. It is at any rate a fact that, since the 1st of October, 1879, when the Act to abolish the export-duty on gold came into force, the quantity of gold entered at the Custom House is very much less than before that date. It will also be seen that the returns furnished by the Mining Registrars, as set forth in the following table, give as the result of the year's operations a larger quantity of gold than the returns of the Mint and Custom House taken together:—

	Mint.	Mining Registrars.	Excess.	Deficiency.
	oz.	oz.	oz.	oz.
Bathurst	15,026	11,006	4,020	..
Tambaroora and Turon	12,392	13,946	..	1,554
Mudgee	15.838	20,092	..	4,254
Lachlan	8,661	18,558	..	9,897
Southern	12,649	19,338	..	6,689
Tumut and Adelong	16,245	18,276	..	2,031
Peel and Uralla	3,677	7,089	..	3,412
New England and Clarence	1,188	3,219	..	2,031
Hunter and Macleay	8,667	9,445	..	778
Not within a Mining District ..	1,101	103	998	..
Localities unknown	21,225	..	21,225	..
			26,243	30,646 26,243
The quantity returned by the Mining Registrars exceeds the quantity sent to the Mint by				4,403

The Mining Registrars endeavour to make their returns complete; but it is evident that they cannot reach all the mines in their respective districts, and therefore it is possible that the output of gold for the year 1880 is considerably in excess of the yield quoted. However, taking the returns of the Mint and Custom House as the most reliable—and they may be said to be thoroughly reliable to the extent that all the gold therein accounted for is the produce of the colony—the output of gold for 1880 exceeds that of 1879 by 8950 oz., valued at 34,324*l*.

The following table shows the results obtained from the treatment of certain parcels of wash-dirt during the years 1879 and 1880 respectively. Unfortunately, returns have been procured in each year from relatively few claims, and, for purposes of comparison, are of little value, because the wash-dirt is not all treated by the same process; and whereas a very small quantity of gold per ton will pay for sluicing, a much larger yield is necessary to make wash-dirt (which requires to be puddled) pay expenses:—

1879.

District.	Quantity.	Average per ton.			Yield of Gold.		
	tons.	oz.	dwt.	gr.	oz.	dwt.	gr.
Bathurst	29,911	0	3	10·45	5,512	0	0
Tambaroora and Turon	475	0	9	7·32	221	0	0
Lachlan	18,054	0	4	9·29	3,960	10	6
Southern	18,772	0	0	13·87	542	9	6
Peel and Uralla	1,300	0	0	17·35	502	0	0
Not in a Mining District	185	0	4	20·75	45	0	0
	68,697	0	3	3·34	10,782	19	12

1880.

District.	Quantity.	Average per ton.			Yield of Gold.		
	tons.	oz.	dwt.	gr.	oz.	dwt.	gr.
Bathurst	21,361	0	3	18·74	4,038	8	0
Mudgee	3,090	0	6	16·00	1,030	0	0
Lachlan	33,443	0	5	3·82	8,626	19	8
Southern	230,790	0	0	4·34	2,091	0	12
Peel and Uralla	3,500	0	2	18·85	487	10	0
	292,184	0	1	2·73	16,273	17	20

The returns for 1879 included a very much smaller quantity of earth that had been sluiced than the returns for 1880, consequently the average yield for 1880 is much smaller than for 1879.

It is greatly to be hoped that miners will in time overcome their antipathy to furnish details of their operations, and that in consequence the Mining Registrars will be able to obtain such complete returns as will admit of a proper comparison, not only between the operations of two or more years, but also of the results by the several modes of treatment of alluvions. Such a statement would be of the greatest value for statistical purposes, and would furnish the best indication of the worth of auriferous deposits.

The following table shows the results obtained from some quartz reefs during the years 1879–80. The returns furnished for 1880 are more complete than those for the preceding year, but the average yield is very much lower. The lowest average is from the Bathurst district; this is due to the fact that in that district some very large reefs are worked for a comparatively small yield. The average yield, though smaller than that of the previous year, is far from unsatisfactory, considering the quantity of stone treated. It is to be hoped that in future large quartz reefs will receive more attention from capitalists, because, though they cannot be profitably worked by the individual miner, they might with the aid of skill and capital be made to yield a very handsome profit, if worked with economy upon a large scale:—

	1879.								1880.							
District.	Quantity.		Average per ton.			Yield of Gold.			Quantity.		Average per ton.			Yield of Gold.		
	tons	cwt.	oz.	dwt.	gr.	oz.	dwt.	gr.	tons	cwt.	oz.	dwt.	gr.	oz.	dwt.	gr.
Bathurst	653	0	0	9	14·22	313	4	0	5,811	0	0	5	11·99	1,597	18	7
Tambaroora and Turon ..	3,220	10	0	15	14·92	2,515	9	14	4,183	10	0	15	6·72	3,196	4	13
Mudgee	1,746	0	0	16	3·99	1,411	6	12	2,420	0	0	9	17·25	1,176	0	0
Lachlan	2,201	10	0	13	13·45	1,492	13	19	3,023	10	0	12	12·48	1,892	15	0
Southern	1,198	15	0	12	13·14	777	16	0	2,102	0	1	0	0·28	2,103	5	0
Tumut & Adelong	2,992	18	1	5	1·12	3,811	7	11	2,528	10	1	4	4·13	3,055	19	18
Peel and Uralla	796	0	1	7	10·76	1,092	9	0	2,447	0	0	17	1·85	2,089	8	0
New England & Clarence ..	550	0	1	0	16·33	568	14	6	66	5	7	3	10·23	475	2	0
Hunter & Macleay	3,125	10	2	17	2·19	8,864	18	1	2,082	15	1	15	21·88	3,813	7	19
	16,464	3	1	5	7·81	20,847	18	15	24,664	10	0	15	17·54	19,400	0	9

From the returns furnished by the Mining Registrars, it would appear that the number of gold-miners in the colony in 1880 was 13,430, including Chinese, which is a very large increase upon the number in 1879. Of this number, 11,403 were engaged in alluvial, and 2027 in quartz mining; while in 1879, the numbers were, alluvial 6476 and quartz 1826. It is quite possible that the increase is not in fact so great as it appears; but there can be little doubt that a large number of persons from outside the colony, or who were following other pursuits within it, were attracted to the Temora and Montreal gold-fields. While no great increase in the number of quartz miners has taken place, the number of alluvial miners has increased in every district except Tambaroora and Turon. The increase in the yield of gold when compared with the increase in the number of miners is small; consequently, in dividing the gold won by the number of miners, the average of their earnings appears exceedingly small, thus:—118,600 oz. divided amongst 13,430 miners, gives less than 9 oz. per man for the year's work. The facts are, however,—(1) That the increase in the number of miners did not take place till the latter half of the year; (2) at new rushes, a considerable number of miners are engaged in looking about or in unproductive labour; (3) a very large portion of the wash-dirt raised at Temora during 1880 could not be treated for want of water. Making due allowance for these special circumstances, the average has probably been quite as good as that of previous years; and taking into account the new discoveries made, and the extent of new ground prospected during the year 1880, the result of the year's operations may fairly be regarded as satisfactory, and on the whole gives promise of considerable improvement in this branch of mining.

The new finds will doubtless give employment to a large number of operative miners, and if capitalists could be induced to undertake the systematic working of the deposits on the older gold-fields, which present ample scope for the profitable employment of capital under skilful and economic management, the gold-fields of this colony would probably take a position second to none in the world.

Barrington [*Back Creek*] *gold-field.*—Following is an abstract of Wilkinson's report (Dec. 30, 1878) on the Back Creek [Barrington] gold-field and the adjacent country.

This gold-field is situated about 10 miles W. from the town of Gloucester, and is at present defined by a strip of country 3 miles wide extending N. from the Barrington river to the Bowman river. Back Creek, where the principal gold-workings occur, takes its rise within this area, amidst steep ranges, which attain an elevation of 800 to 1500 ft. above the Barrington and Bowman rivers. These ranges are covered with a thick forest of box, cedar, gum, mahogany, and other timber useful for mining and building purposes, together with a dense undergrowth of scrub, vines, and ferns, resembling the luxuriant vegetation of the Illawarra district and of Gippsland, Victoria, so that the miners have had no slight difficulty to contend with in clearing and forming dray-roads from their mines to the crushing-machines and the township. The township is situated near the junction of the two main branches (called right and left) of Back Creek, but it is being rapidly extended up the left branch. There is very little level ground suitable for building upon, owing to the steep declivity of the hills, reaching in places to the bank of the creek. A township has therefore been recently surveyed on more suitable ground, about a mile below the junction of the right and left branches, but the former locality being nearer to the reefs, all the houses of business are there at present, and the building allotments command a high price.

On this gold-field, 20 distinct lines of gold-bearing reefs have been proved. On nearly all of these, the claimholders or leaseholders are either raising stone for crushing, or further prospecting the reefs, while waiting an opportunity for the crushing of the quartz already raised. In some of the claims, other gold-bearing veins have been discovered; for instance, there are 3 on the Hidden Treasure or Town and Country line, whilst on the Rose and Thistle line, at the head of the right branch, there are 5 or 6 sets of veins, from some of which rich specimens have been obtained.

The Mountain Maid reef, from which 235 tons have been crushed, yielding over 15 oz. of gold per ton, averages about 14 in. thick, but varies from 4 in. to 26 in.; it has been opened for about 160 ft. along its course, which strikes from E. 15° N. to N.E., underlying slightly to the S.E. The strata of hard shale and sandstone which it traverses dip S. 20° E. at 25°. The deepest shaft is 100 ft. The reef is accompanied in places by a breccia vein, enclosing angular pieces of the bounding walls; it contains much pyrites and a little gold, and appears to have been formed subsequently to the rich vein, for some specimens show one vein intersecting the other. The Rainbow reef is on the same line, farther N.E. In the prospecting-claim, at a depth of 50 ft., the reef occurs in a channel 2 ft. wide, within which the reef splits irregularly into several veins, separated by partings of black shale, and forms again. Its strike is E. 43° N., slightly underlying to the S.E., and the strata it traverses dip S. 35° E. at 12°. The Hidden Treasure reef (Cameron and party's), on the Town and Country line of reef, is being worked by a tunnel. It varies from 6 in. to 6 ft. thick, averaging 3 ft., and underlies to the S.W. at an angle of 45°. It traverses indurated shales and sandstones dipping S. 22° W. at 20°. On the hanging-wall, in places occurs a casing of unctuous clay, and the face of the quartz in contact with it has a highly polished surface; 100 tons from this reef yielded 3 oz. per ton. About 150 tons, showing gold freely, now await crushing. The Centennial reef lies farther to the N.W., and also dips to the S.W.

It is said to average 2 ft. 6 in. thick, varying from 6 in. to 6 ft. Two shafts have been sunk on it to depths of 50 and 90 ft. It occurs almost on the summit of the watershed, at the head of the left branch, and about 800 ft. above the level of the township; 147 tons crushed yielded nearly 2 oz. per ton, and about 400 tons of similar stone are now ready for crushing. Between this reef and the Hidden Treasure, on the same line, are other claims on smaller gold-bearing veins, 4 of which have been discovered, 2 to 20 in. thick. One of these, the Town and Country reef (Harris and party's), was the first reef opened on this gold-field. In another claim on the Centennial line, the Golden Crown (Lukey, Young, and party's), the reef is 5 to 20 in. wide, and dips with the strata S. 35° W. at 42°; 48 tons yielded 2 to 5 oz. per ton. A shaft has been sunk upon it for 70 ft. The Anderson line of reef strikes almost E. and W.; it runs in lenticular shoots of quartz from a few inches up to 2 ft. 6 in. thick; 84 tons crushed from one claim on it, the Lady Belmore, yielded 2 to 4 oz. per ton. There are other claims at work on this reef. Both the crushing-machines on this creek at the time of his visit were idle, owing to the scarcity of water; this shows the necessity for early provision being made for the conservation of an adequate supply of water for crushing purposes.

Miller's reef and the Rose and Thistle reef at the head of the right branch are chiefly in hard metamorphic conglomerate. In Doust's claim, on the latter reef, the quartz averages 8 in. thick, and looks promising; it contains a little galena. In May, Robinson, and Smith's claim, the average thickness of the stone is 7 in., but it is sometimes even 1 ft. thick. From another vein in this claim, he was informed that 179 oz. were "dollied" (crushed by hand) from about 6 cwt. of stone; and in the adjoining claim, 75 oz. were got from one bucketful of stuff. The reefs in the prospectors' claim on the Lady Matilda line, and Cripps & Co.'s on the Rose and Thistle line, are in indurated shale; in the former, the reef varies from a few inches to 3 ft. thick, running in irregular shoots, and dipping generally with the shales from S. at 35° to S. 22° W. at 21°. A trial crushing of 1½ ton gave 3 oz. of gold; about 120 tons of quartz are ready for crushing. A short distance farther E. is the Royal Bengal Tiger reef, which strikes in quite a different direction to the last, viz. N. 25° E.; it has been opened to a depth of 40 ft. Other reefs have been found in this locality. The quartz raised from the various reefs at the head of the right branch is awaiting the completion of the battery which Williams & Co. are erecting on the creek. The stone which he saw in some of the heaps shows gold freely, and it is expected will give good results.

The Morning Star line of reef is near the Back Creek township. In Fallon's claim, No. 1 west, it dips N. 30° W. at about 43°. Two very ferruginous veins, 2 in. thick each and 3 ft. apart, were followed in an E. direction for a short distance, when they united and became 10 to 15 in. thick; 16 tons from this reef gave 2½ oz. per ton, and the stone at grass is expected to give a much richer yield. In Baird and Slade's 3-acre lease, No. 1 east, the reef is 6 to 16 in. thick, striking E. 10° N., with underlie northerly; it has been opened to a depth of 90 ft.; 18 tons crushed yielded 2 oz. per ton. The Melbourne reef lies to the south of the Rainbow line; it averages 8 or 9 in. in thickness, and strikes N. 20° E., underlying E. The owners, Massey and Reid, showed some rich specimens from the claim; one small piece weighing about 4 oz. consisted almost entirely of fibrous filaments and crystals of gold, partly encrusted with oxide of iron, evidently derived from the decomposition of pyrites. About 1⅓ mile S. of the township, on the Church and School lands, is the Mechanics reef, which crosses the summit of the high range between Back Creek and the Barrington river, at about 1000 ft. above the river. It strikes E. 35° N., underlying a little to the S.E., and averages 2 ft. thick, but varies from 6 in. to 2 ft. 6 in. In the No. 1 claim south, the shaft is down 140 ft., which is as yet the deepest shaft on this gold-field. Like the Mountain Maid reef, this reef is accompanied by a brecciated vein containing angular fragments of sandstone and shale, with calcite and much iron-pyrites, and also a little gold. The country consists of hard sandstones and shale, dipping E. 4° S. at 31°; 348 tons of quartz from this reef yielded 2 oz. 13 dwt. per ton. A good road has been formed for the carriage of the quartz from the reef to Watt and Driscoll's crushing-machine at the Rainbow. Other reefs being worked are not mentioned, but the preceding will suffice to show the main features of the reefs on this gold-field.

Parcels of quartz crushed at Watt and Driscoll's machine, at the Rainbow reef gave :—

Name of Reef.	Crushed.	Yield per ton.
Prospectors' claim, Rainbow Reef	97 tons.	1½ oz., about.
No. 1, Rainbow Reef	58 ,,	2 oz.
Prospectors' claim, Lord of the Hills Reef	10 ,,	1 oz.
No. 1, Mechanics Reef	135 ,,	2 oz. 15 dwt., about.
Prospectors' claim, Rainbow Reef	21 ,,	5 oz.
Prospectors' claim, Mechanics Reef	9 ,,	5 oz.
No. 1, Lord of the Hills Reef	33 ,,	15 dwt. about.
Star of the South Reef	9 ,,	1½ oz.
Sawyers' Reef	12 ,,	12 dwt.
Mountain Maid Reef	82 ,,	15 oz. 18 dwt.
No. 1, Morning Star	18½ ,,	2 oz.
Prospectors' claim, Morning Star Reef	19¼ ,,	1½ oz.
No. 1, Morning Star Reef	16 ,,	2½ oz.
Prospectors' claim, Rainbow Reef	56 ,,	1 oz.
No. 1, Rainbow Reef	23 ,,	1¼ oz., about.
Rosetta Reef	26 ,,	18 dwt.
No. 1, Mechanics Reef	129·8 dwt.	3 oz. 14 dwt.
Prospectors' claim, Rainbow Reef	15 tons.	6 oz.
Prospectors' claim, Mountain Maid Reef	153 ,,	15 oz. 15 dwt.
Prospectors' claim, Mechanics Reef	75 ,,	1 oz. 16 dwt.

Higher up the left branch is Burley and Thomas's crushing-battery, at which over 500 tons of quartz had been treated; 379 tons crushed gave an average yield of about 2 oz. 12½ dwt. per ton.

From these interesting particulars, it will be seen that 1244 tons of quartz yielded about 6153 oz. of gold, the lowest yield being 12 dwt. per ton from a small parcel of 12 tons of quartz, and the highest nearly 16 oz. per ton from 235 tons from the Mountain Maid claim. If we disregard the latter as being exceptionally high, the average yield of all the other crushings, viz. 1009 tons, will be at the rate of 2 oz. 8 dwt. 9 gr. per ton, which may be taken as about the general average yield of the reefs on this gold-field. Wilkinson estimated that there were upwards of 1500 tons of quartz raised awaiting crushing.

Alluvial gold was first discovered on Back Creek in May 1876. E. F. Pittman, geological surveyor, in his accurate report on this gold-field, states that the first gold-mining lease (quartz) was pegged out on 25th November, 1876. At the beginning of the present year, the population numbered about 250; since then it has increased to about 1100, of whom 800 are miners.

The alluvium in the creek beds both of the right and left branches has been worked for gold almost from their sources to their junction, with payable but not rich results, though several fine nuggets have been obtained—one of 8 oz. in weight found on the left branch, near the Rainbow reef; and several, with one of 35 oz., in the creek near the reefs at the head of the right branch. About 10 miles W. from Back Creek, have been some old alluvial workings on the Burneal Creek, a creek about 3 miles in length, which runs into the Barrington river. Here Thomas, Luke, and party discovered a quartz reef near the summit of the range between the Burneal Creek and the Barrington river. The reef traverses brown sandstone, shows gold freely with iron-pyrites and galena; it runs 6 to 12 in. thick, nearly vertical, and strikes E. 40° N.; it is being opened by a drive from its outcrop on the face of the steep range. Several other quartz reefs have been found in the locality, but as yet no gold has been seen in them; some of them will, however, Wilkinson believes, be found auriferous. The formation of the country is similar to that at Back Creek, but apparently in a higher series of strata, in which he found *Crinoid* stems, *Strophomena*, *Spirifer*, &c., and other marine shells. These fossils occur in abundance in the rocks cropping out in the creek near the homestead on the Cobark station. About 4 miles farther S. a miner named Jackson has opened a reef, which Wilkinson had not time to visit; it is said to average 15 in. thick, and to contain fine gold. Gold has been found in the alluvial on Mount Moonie, 6 miles N. from the Cobark station, and also in the intervening country, so that there is every probability of auriferous reefs being found throughout this locality, and between it and Back Creek, especially in the vicinity of the Two Creeks, near the Barrington, where payable alluvial gold has been got. Several gold-bearing reefs are now being opened near the Bowman river, about 5 miles N.W. from Back Creek. There are two parallel reefs within about 200 yd. of each other; they strike N. 40° E., underlying to the S.E.; a third vein, the John Bright, 6 to 18 in. thick, occurs between them. The formation of the country is hard blue sandstone and shale. There are 6 claims at work, chiefly on the Golden Spur reef, which in the prospectors' claim varies from 12 to 20 in. thick, the stone showing coarse gold. The other reef, the Gladstone, was the first discovered, and worked to a depth of 50 ft. some time ago by Selby, who abandoned it, until Hughes and Dyson, about 3 months ago, opened it again. There are now about 50 tons of gold-bearing stone at grass. At present the gold is extracted by "dollying" (crushing by hand with a wooden stamper suspended from the end of a spring-pole). There are good sites for a crushing-machine on the Bowman river, within ½ mile from the reefs. The gullies on either side of the reefs have been more or less worked for alluvial gold, and, as it has been obtained in them for some distance above the line of the reefs already discovered, there is no doubt that other gold-bearing reefs exist in the ranges lying to the S. This country is worthy of being prospected.

Wilkinson also inspected the two reefs lately discovered about 4 miles W. from Dungog, and about 30 miles S. from Back Creek. One of these, Gurr and party's, is on the Sugarloaf Range. This reef consists of a network of veins in green chlorite rock, 12 to 18 in. thick, sometimes making into solid quartz containing iron-pyrites. Some specimens, said to have been taken from near the surface, showed gold freely; the reef strikes N. 20° W., and is nearly vertical. About 1 mile farther S., on a spur from the main range, occurs another reef, about 1 ft. thick, in brown sandstone; it has only been opened to a depth of about 4 ft.; it was said to contain gold, but he did not see any in the quartz. These reefs are in rock of the same formation as those at Back Creek, and certainly deserve prospecting. Alluvial gold has been found in the country between Dungog and Barrington, and, as this tract of country is all more or less of the same geological formation, there is every reason to believe that many payable quartz reefs will be discovered in it, and prospecting throughout the district should be encouraged.

As a rule, the lines of reefs follow the strike of the strata; but there are one or two exceptions, as in the Morning Star line, where their course is almost in the direction of the dip of the strata; consequently reefs are found running towards various points of the compass. This may be partly due to the fact that the strata (Upper Devonian) which these reefs traverse have not been affected by cleavage as have been the older Silurian formations, which are the principal reef-bearing rocks on some gold-fields. The fissures which the quartz has filled opened where the strata offered least resistance to the contracting or other forces causing the fractures; and as these strata of shales, sandstones, and conglomerates vary considerably in composition and hardness, and in the direction of their dip, there is little difficulty in accounting for the irregular reefs formed in them. Under these conditions, are found, as might be expected, sets of reefs extending perhaps in one general line, but each reef of irregular thickness and length—just as in the splitting of a piece of cross-grained timber, which does not split in one straight line, but opens in small cracks along the main line of fracture. These considerations are of importance to the miner, as showing that the thickness of the reefs cannot be relied upon for continuance in either length or depth, and that some reefs may even thin out altogether, but will probably be connected by distinct joints with other similar veins not far off; and thus it is assured, that though the yields from individual mines will fluctuate considerably at times, yet on the whole the quartz-mining industry in this gold-field may be regarded as of a permanent character. Much will depend upon the systematic development of such reefs. Their variable thickness and extent suggest the precaution of providing in many instances a reserve fund for occasional prospecting, and the advantage of the management of the mining operations being under interested and local directors. These and other considerations should not be disregarded, for by mismanagement, either of a company's mine or of its funds, a good mine may be brought to a standstill, many incautious investors ruined, and the development of the mining industry retarded. Most of the mines are at present held and satisfactorily worked by *boná fide* miners, aided sometimes by others who are represented by wages men. In such private companies as these, where the labour and capital employed are mutually interested, the first development of a mine is generally attended by the most satisfactory results.

The water supply for Back Creek is very uncertain. In summer, the creeks cease running, and the supply has to be drawn from holes in the alluvium, the water from which is brackish and unwholesome. To remedy this deficiency, much might be done temporarily by the residents themselves in making dams and tanks, for the construction of which the conformation of the ground is suitable, though the bed-rock is often of a very jointed nature, causing much loss of water by infiltration; but by judicious selection of site for a dam, and by puddling, the loss might readily be prevented. For the purpose of ascertaining whether a permanent supply could be obtained for this gold-field, Wilkinson examined the surrounding country, and found it must be sought for within the watershed of the Barrington river, as the Bowman stream is not sufficient for the purpose.

Two schemes present themselves: these are to obtain the water either by pumping from some point on the Barrington river, or by gravitation from the Arundel river. Either of these schemes might be too costly for adoption until the requirements of the gold-field are more fully developed; but of the two, the former would probably be the less expensive, for the Barrington river has such a rapid and large stream that any required water-power might be made available for pumping, so that steam-power might be dispensed with. The nearest point of the Barrington river to the Back Creek township is about 2¾ miles distant, in a S.W. direction, and a high range intervenes, the lowest gap in which, at the head of Black Jack Gully, is about 800 ft. (aneroid observation) above the Barrington river, while the confluence of Back Creek and the Barrington river is about 500 ft. lower level than the township. So that water would have either to be pumped up the valley of Back Creek to a height of 500 ft., and for a distance of 5 miles, or else for about 1 mile on to a range 900 ft. high, whence it might descend by gravitation to the township, a distance of 2 miles, or to any other required part of the diggings. The gravitation scheme to bring water from the Arundel river and its branch, the Delgree Delgree Creek, above Cobark station, would necessitate the cutting a race between 30 and 40 miles in length through very rocky country; and as payable reefs are likely to be found in any part of this country, future discovery may render the construction of this water-race advantageous to the district. Wilkinson was informed that the Back Creek Progress Committee had applied for a small water reserve to be made on Duffer Gully. He examined this gully, which is conveniently situated for the purpose. This reserve should, he thinks, be made to include the ground for a width of 5 chains on both sides of the bed of the gully, and for a distance of ½ mile along it from its junction with the right branch. In this area, a reservoir might be made at an elevation of 100 ft. above the town, to which the water might be conducted by a line of pipe about ½ mile in length.

Kiandra gold-field.—Following is an abstract of Lamont Young's report on the Kiandra gold-field, and a water-supply for the same; dated 25 May, 1880.

Kiandra is situated on the table-land of Maneero, 5000 ft. above sea-level, and close to the highest mountains in the colony: within a radius of 16 miles, may be seen the sources of the Snowy river, the Murrumbidgee, the Tumut, a large tributary of the latter, joining it 175 miles from its source, and flowing for the first 35 miles in a diametrically opposite direction, and finally some minor tributaries of the Murray

[Hume] river. Under these conditions, it may appear at first sight strange that alluvial deposits of any extent should exist in the neighbourhood of Kiandra,—deposits so extensive as to promise many years of employment, and lying so high up in the surrounding hills that the supply of water requisite to work them has but a small gathering-ground; indeed, were it not for some natural features hereafter to be enumerated, any attempts to institute hydraulic mining on a large scale would be hopeless.

With the aid of a compensated aneroid, Young ascertained that a fair amount of water, enough to supply 20 sluice-heads continuously, could be obtained from the left-hand branch of the Tumut river; two gaps, however, were unfortunately found to occur between the source of the water and the first diggings at which it would be available. These gaps, known as the Snowvale and Russell's Corner respectively, are too deep to be bridged over with fluming, and the only way by which the water could be taken across them would be by inverted siphons. The length of the race up to the Nine-mile diggings, the first place where the water would be used, would be about 25 miles, and an additional 12 miles would be required to take water on to the New Chum Hill and Township Hill deposits. Lett informed him that 100*l.* a mile would in his opinion amply cover the cost of constructing this race; and as this gentleman had himself cut quite 20 miles of races in the neighbourhood, his estimate may be taken as a fair one. Sullivan's surveys (see p. 507) will decide whether water can be brought from the Tumut river to work the extensive deposits at Nine-mile, Four-mile, New Chum Hill, and Township Hill diggings. Young is convinced that the above river is the only source of a water-supply; for though sites for dams exist in the neighbourhood of the diggings, the amount of water they could contain would be quite trifling compared with the demand. He, however, mentions that for one or two claims the present supply might be supplemented: thus, a fair-sized dam could be made on the site of the Three-mile diggings, which is practically worked out, and this water used for the claims on New Chum Hill. There is also a good site for a dam just behind Mount Tabletop, from which the water could be brought on to the Empress claim. Near the end of this report (see p. 503) is appended a short notice of each locality where digging is carried on.

In the neighbourhood of Kiandra, the country spreads out into large fan-shaped flats, which drain through narrow outlets. This appearance is very strikingly developed, and sometimes on a large scale, as in the extensive flat above the junction of Bullock Head Creek with the Eucumbene river; here the Eucumbene drains through a deep narrow gap, the damming of which would convert the flat above into a large lake. These flats at their upper extremities appear but little inclined towards the outlet, and are filled with a peaty kind of soil, in places becoming soft bogs and quagmires; over the whole grows a luxuriance of heaths, ferns, and mosses. Just near the outlet a sudden and rapid fall of the surface takes place, a small stream of water appears, and, after draining through a little gorge, is again lost in a larger flat beyond, into which several small flats drain. When once a stream of water of any size is formed, it is seen to flow through deep narrow gullies and over a bed of pebbles. As an examination of these appearances will explain some points connected with the auriferous deposits of the neighbourhood, they will be described more in detail.

These fan-shaped flats are the gathering-grounds of the snow, which falls in great quantities during the winter months; in them—thus protected during the cold season, and nourished during the spring and autumn months by fogs—ferns, mosses, and heaths grow luxuriantly. These, in the course of time, form spongy peats, which are the reservoirs of the melted snow-waters, and from which a clear, steady stream drains all through the summer, the slight brown tint of which clearly indicates the peaty nature of the ground at its source. The semi-solid state of the surface-soil in the high flats is owing to its being largely composed of a porous mass of decaying vegetable matter, held together by the stems and fibres of the plants that form it; near the outlet, where the drainage becomes confined, the flow of water naturally increases in rapidity, and all soft decaying vegetable matter and soil are carried away by the stream, hence the sudden fall at the outlet of the flats where the peat-bog abruptly ends. When once a body of water is formed, so constant is its bulk during the summer, and so considerable during the spring, that a deep narrow gully is soon cut and maintained. The small size of the pebbles that lie in the beds of the streams cannot owe their appearance to the cause that usually produces it, namely grinding against each other, since these streams, though rapid, are not considerable enough to carry along the pebbles. The explanation in Young's opinion is as follows:—The pebbles are of granite and slate, such being the formations of the surrounding country, the highest points, as a rule, being slate. During the intense cold that these rocks are exposed to for the greater part of the year, they must, where unprotected by vegetation, be greatly affected by the frost, and not merely be broken off in blocks, but these latter themselves shattered and seamed with incipient fractures; when, therefore, the débris is carried by the melting snows or by thunderstorms to lower levels, the whole readily fall in small fragments. Where any very water-worn pebbles are met with, it may be confidently affirmed that they have come out of the auriferous deposits of the district, or neighbouring conglomerates. Quartz reefs occur in both the granite and slate formations, and in two or three cases have yielded considerable amounts of gold: but the numerous discoveries of gold during the time they were being worked, and the inclement winter of the locality, caused them to be abandoned as soon as the rich surface patches were worked out. Fragments of these quartz reefs are often to be seen in the beds of the present streams.

The locality of these diggings, as it has been exposed to intense cold, has also been the scene of the outbreak of subterraneous fire. Rising into a lofty peak in Mount Tabletop, covering a great extent of country, and, wherever exposed, the auriferous alluvial, occurs a great deposit of basalt, marking in nature's most permanent outlines the course of an ancient lava-flow. Whether Mount Tabletop was one of the spots where the lava burst out, or the only one, has not yet been definitely settled. From its elevated position above the rest of the basalt — from the hollow in the top of the mountain—from the peculiar appearance, like solidified streams of basalt, shown in the steep sides on the N. and N.E.—and from finding a piece of volcanic breccia on the summit—Young is of opinion that the mountain marks the spot whence came most of the basalt on the E. side of the Tumut river. When this outbreak filled the valley and flats of the surrounding country, the adjacent hills must have been of a much greater altitude, since they are now, with few exceptions, below the level of the basalt, which therefore forms an elevated ridge, occasionally spreading into small table-lands. Buried beneath this hard covering, lie the auriferous gravels, and it is only where recent streams have cut narrow passages through it, or the surrounding country has been denuded away from the sides of the flow, that the alluvial deposits have been exposed. This latter process has occasionally occurred on so large a scale that the basalt has been as it were undercut, the alluvial below it being washed out, and great falls of basalt, often columnar, have taken place. This is especially well seen where the Eucumbene river skirts the basalt formation, some 3 miles below Kiandra.

It has thus been owing to the denudation of the neighbouring formations and the subsequent denudation of the fringe of the basalt formation, that the underlying gold-drift has been washed out and down the sides of the present hills, and it has in nearly every case been in tracing up some such little lead of gold that the digger has been led to the discovery of the main deposit. Up to the present this main deposit has been but slightly worked, that is in comparison to its extent, and a notable feature that has been exposed is the presence of a deposit of clay, more or less carbonaceous, and at times so highly so as to be almost a peat. This deposit lies over the gold-drift, and, like the latter, always has a slight dip into the hill, increasing in thickness as it gets farther in. Two or three fine sections are shown in the claims. The carbonaceous clay, as also the clay-seams above and below it, contain plant-remains more or less perfectly preserved, and during Young's stay in the locality, he dissected out some 200 specimens of leaves; the majority from their form and venation appear to be allied to the genus *Eucalyptus*, but as yet the specimens have not been worked out. Some of the wood preserved in the clay above the leaf-beds is remarkably fresh-looking. In the sand-deposit that intervenes between the leaf-bed and the coarser auriferous drift, as also in the latter, false bedding is often to be seen. In the drift itself, an enormous quantity of very rounded pebbles occur, and Young thinks there is little doubt that they are the remains of conglomerates, similar to those at Lob's Hole, and which, during the Post-Pliocene period, were broken up and washed, together with the auriferous reefs of the neighbouring slates, into the channels in which they are now found. Much of the auriferous quartz was full of iron-pyrites, as shown by specimens found in the leads, and this is doubtless the cause of the cement-bands and iron infiltration markings in the finer drift. The bed-rock on which the deposits rest is a Silurian slate, seamed with quartz veins and iron infiltration markings. In one place, the Four-mile diggings, the drift rests on granite. In the neighbourhood of Kiandra, are several kinds of granite, some highly hornblendic, with pink felspar; another near the head of the Tumut river with no hornblende but white felspar, the quartz predominating, and of a gneissoid structure; while a third variety, on which the township is built, contains a quantity of zircon and iron-pyrites.

From an examination of the sections in the different claims, and the characteristic appearances described, it would appear that after the auriferous alluvium, composed of the débris of slates, conglomerates, and gold-bearing quartz reefs, had been spread out in the ancient water-channels, a quantity of sediments were deposited thereon, and subsequently on these latter a growth of ferns, mosses, and small shrubs, similar to the deposits now forming, lived and died, thus giving rise to the carbonaceous clays and earthy lignites, to which Young has given the name of leaf-beds. These in their turn were covered by deposits of clay and sand, and finally, over the whole, flowed and solidified a stream of lava. The time which must have elapsed between the deposition of the auriferous gravels and the present, when the then adjacent mountains have become valleys, and the old river-bed, protected by its basalt capping, left high up in the sides of the present hills, may appear, to persons unaccustomed to reckon by geological time, very great; and yet, considerable as it may be, some of the wood in the leaf-beds retains its natural colour, and thousands of the leaves still exhibit every vein that meshed their surface. To the geologist, this is a most interesting locality, and Young has little doubt that if the area of the basalt formation were mapped out, some valuable information as to the position of the auriferous deposits would become apparent, that is to say, the direction and extent of the old river-bed would be more or less clearly indicated. From the widely separated localities in which the deposits have been found, there is evidently an immense area available, the only payable method of working which, at present known, is by hydraulic mining.

The following are the chief localities in which gold-mining has been carried on:—

Nine-mile diggings.—The shallow ground in this locality has long since been worked out. At the present time, it is being re-worked by 8 parties, who are only able to work during three months of the year, owing chiefly to the want of water. This year (1880) none of them had enough water to wash up. These diggings were very rich, and remarkable from the presence of large blocks of a quartz breccia, containing subangular fragments. The cementing material is silica.

There is one large sluicing claim called the Empress. The wash is composed of quartz pebbles in various stages of attrition, sandstone pebbles highly water-worn, and large masses of jasperoid quartz, evidently derived from a neighbouring reef that has been intersected by the tail-race of the claim. The following is a section of the deposits exposed in the open cut:—

	Ft.
Surface soil, gravel, and sand, in places thicker, and containing blocks of basalt, derived from the ridge at the back	18
Clay	3
Clay containing stems of small trees	3½
Carbonaceous clay, containing leaves, &c.	4½
Clay	2½
"Wash" impregnated with oxide of iron	18
Clay	3½
Wash	30
Total thickness of deposit	83

The bed-rock is a Silurian slate, yellow in colour, and much decomposed. The stems of small trees contained in the second layer of clay are all more or less flattened, and in various stages of decomposition, at times the wood being almost of its natural colour, while occasionally specimens occur converted into lignite, and exhibiting a fracture like charcoal. Many of the wood specimens show joints. The most abundant leaf found in the carbonaceous clay is apparently a variety of *Pteris esculenta*, which now grows abundantly in the locality. Similar leaves were found in the Pliocene leads on the Gulgong gold-field. In places, this leaf seems to form the bulk of the organic matter which is irregularly distributed through the 4½-ft. clay band. Fresh fractures in the carbonaceous clay were decidedly conchoidal, reminding the observer of kerosene shale, but when exposed to the weather, it soon split up into flakes like ordinary shales, and whitened considerably.

Beyond a doubt, the shallow diggings in this locality have been due to some of the thick deposit being washed out of the hillsides, while the scarcity of water is the cause of there being only one claim in the deep ground. Here, as in the other localities where the old lead is worked, the party who first get the water have practically possession of all the ground. The yield of the Empress claim is said to be 10*l.* a man per week.

New Chum Hill diggings.—The Emperor claim consists of a large open cut, and a tunnel 1200 ft. long, which was driven into the hill with a view of striking the deep ground, in which, however, it has not succeeded. Comparatively little wash has been removed from the workings; the yield was 1½ to 3½ dwt. to the ton, after crushing the wash in a battery. The latter was being removed at the time of Young's visit, and the claim had not been worked for some time.

The Homeward Bound claim is a large open cut, and has been worked continuously for 19 years. Sluicing operations can, however, only be carried on for 10 to 12 weeks in the year; yield, 6*l.* to 10*l.* a man per week.

On the Scotchman's Tunnel claim, the present tunnel is 700 ft. long; one driven at a higher level was 1200 ft. long; it, however, struck the wash so high up that it has since been abandoned. The claim has been worked continuously for 19 years. The bottom of the wash only is removed, and is treated in the valley below the claim. An iron-pyrites cement occurs in places at the bottom of the wash, and sticking in the lower side of the cement are highly water-worn grains of gold. Trunks of small trees converted into lignite are also met with.

The drift of New Chum Hill is composed of quartz pebbles of various degrees of roundness, also very water-worn sandstone pebbles, sand, clay, and included fragments of the slate bed-rock. The succession and nature of the deposits vary somewhat from that seen in the Empress claim. The following is the section shown in the Emperor claim:—

	Ft.
Basalt	1½
Clay	8
Carbonaceous clay, leaves, fern-stems, &c.	8
Pipeclay	8
Sand	4
Clay (very fine, like fire-clay)	1½
Clay	5
Carbonaceous clay	35
Clay (very white and fine)	15
Wash-dirt	30
Total thickness of deposits	116

Bullock Head Creek.—This creek flows between New Chum Hill and Township Hill, and was found to be very rich from below the Emperor claim to its junction with the Eucumbene river; it is now supposed to be worked out.

Eucumbene river.—This stream flows past the E. extremity of New Chum Hill; it has been worked for 4 miles above its junction with Bullock Head Creek, but it was richest at and below New Chum Hill. The river has also been worked in places for 5 miles below the town of Kiandra, that is 6 miles below the junction just mentioned. The river here passes through a narrow gorge filled with huge boulders, and locally known as the Rocky Cañon; lower down the river, payable gold has also been found. At the time of Young's visit, in one claim 3 miles from the township, 4 men were working the bed of the river, having diverted the water, and during one week realized 25 oz. The bed-rock at this claim was a very highly hornblendic granite.

The river-slopes just below the township of Kiandra contain the following rich patches of shallow alluvial and reefs:—(1) Whipstick Flat, a very rich spot; much of the gold was evidently derived from a reef at the head of a flat, and which was itself worked; just below the reef, a 28-lb. nugget of gold with a few fragments of quartz sticking in it was found. (2) Surface Hill: another very rich patch traversed by a large quartz reef; from the adjoining gully (Pollock's Gully), a great quantity of gold was extracted, and numerous zircons were found in the wash; these appear to be derived from a hornblendic granite that crops out at the township; a portion of Surface Hill is of slate formation. (3) Whipstick reef: worked down for 14 ft. from the surface, when the yield falling off, it was abandoned; the surface stone went 3 oz. 3 dwt. to the ton, and the last crushing went only 18 dwt.; the reef is in slate, and the old working having fallen in, Young was unable to indicate its strike and dip; it appears, however, to form a half-circle at the spot where it was worked, and is, he believes, a leader to the large reef on Surface Hill, which has a strike N. 5° W., is 3 to 8 ft. wide, and dips W. at an angle of 79° with the horizontal. (4) Charcoal reef: situated near the Eucumbene river, on the opposite bank; shaft was sunk 60 ft. deep, and the yield is reported to have been 4 oz. to the ton; the reef was in slate, and 9 in. wide; this last fact, coupled with the quantity of water contained in the adjoining rocks, caused it to be abandoned.

Three-mile diggings.—The gold in this spot was derived from a large reef and leaders known as the Three-mile reef. At the present time, one party of Chinese and one European are fossicking in the old ground. Large pieces of specular iron-ore and psilomelane occur in the drift.

The Three-mile reef is in slate; its strike is S. 20° W., dipping

N.W. but very slightly, being almost perpendicular; it has a width of 2 to 3 ft.; 500 tons were crushed, and yielded 1 oz. to the ton. The reef was sunk on for 40 ft., and then stoped away from the surface. It has not been worked for 10 months, on account of the shaft and workings being flooded—the surrounding rocks contain a great deal of water. A tunnel was put in 800 ft. to tap off the water, but was abandoned on account of the hard nature of the rock met with. It was estimated that 300 ft. more would intersect the reef at a depth of 150 ft. from the surface. A very rich leader was found adjoining this reef, and subsequently lost: 4 men extracted 1500*l.* worth of gold from it in 4 weeks.

Township Hill diggings.—Both in this hill, which is opposite to New Chum Hill, and in New Chum Hill itself, numerous shafts were sunk through the basalt capping which overlies the wash; in every case, however, the quantity of water met with prevented the shafts being bottomed. One shaft, just above the town, was sunk through 12 ft. of basalt and 38 ft. into the alluvium, when it had to be abandoned. Opposite the Emperor claim, the carbonaceous clay band is exposed in the hillside. Here a company began a tunnel, with a view to striking the lowest portion of the deposit, which at this spot dips rapidly into the hill. The site chosen for the tunnel was rather low, and, after driving 500 ft., some very hard rock was met with, and the venture thereupon abandoned.

Four-mile diggings.—These diggings are situated between Kiandra and the Nine-mile, on the edge of the basalt formation. A long gully that drains from the spot into the Eucumbene river furnished a considerable amount of gold, which was evidently derived from the deposit under the basalt. The shallow workings are now abandoned, and one party only are working the deep ground, the peculiarity of which is that it rests partly on granite.

Eight-mile diggings.—Only one claim is being worked here; the ground has been opened in two places. The deposit was discovered by a small lead being traced up the hillside. The carbonaceous clay and clay bands occur as at the Nine-mile and other places. Comparatively little work has been done on the spot, and as yet the thickness of the wash-dirt is only 8 ft.; the greater portion of this is more or less cemented by oxide of iron. The bed-rock is a Silurian slate, highly contorted, seamed with quartz and iron veins, and occasionally very micaceous. Old tree trunks with roots attached, and standing upright in the recent alluvial deposits, have been found. The approximate yield of this claim, which can only be worked during a few weeks in the year, is 4*l.* to 7*l.* per man a week.

Fifteen-mile diggings.—Situated on the left bank of the Tumut river, and in all respects a similar deposit to the last, the only peculiarity being the occurrence of granite pebbles in the wash. It may be mentioned also that some of the basalt of the locality has a semi-columnar structure. There is only one claim, but in the Tumut river, some 2 miles distant, a party of Chinese are working the river banks, which in former days yielded enormous quantities of gold. The rocks of the neighbourhood are slates, and occasional small veins of yellow copper-ore are found in them, similar to those at Lob's Hole, but of less size.

In conclusion, Young states his conviction that very extensive and payable deposits of auriferous alluvion occur in the neighbourhood of Kiandra, and there is every indication that, should the gutter of the old river-bed be struck at any of the localities mentioned, it would prove exceedingly rich.

The report (dated June 10, 1880) of Sullivan's surveys for bringing water to the Kiandra diggings, alluded to on p. 499, may be summarized as follows.

He selected as datum-level a point about 120 ft. above the level of the wash in the Empress claim, the principal claim on the Nine-mile diggings, because not only would water from it be available for the Nine-mile claims, but also for the other auriferous deposits in the Kiandra district; thence he ran a contour line following the main range which separates the waters of the Tumut and the Eucumbene rivers. At 9½ miles from the start, the range falls suddenly, and causes a small break 550 links wide, across which the water may be brought by fluming, as the break in the lowest part is only 30 ft. above the datum-point; 30 chains farther on is Russell's Gap, which is below the level for a distance of 370 chains, and at the lowest place is 292 ft. below the datum-point. The range is then very low for a considerable distance, and 3 other gaps occur at short intervals, — Harnett's, Barney's, and Snowvale Gaps. After leaving the Snowvale, the range rises very rapidly, and, with the exception of two small breaks, is much higher than the Nine-mile claims. Owing to the lateness of the season, Sullivan could not fix a point on Doubtful Creek which would allow sufficient fall to the claims; but he reached the creek a little lower down, at a point 72·67 ft. above datum-point. The stream at this place is 12 to 15 ft. wide and nearly 3 ft. deep, and has a fall of 80 ft. per mile. The valley through which it flows is very swampy, and abounds in small brooklets, which seem to be fed by the melting snow.

The total length of the race may be set down very approximately as 30 miles. The ground over which the water would be brought is, with the exception of a small extent of basalt near the Nine-mile, entirely of diorite and granite formation, and, where the latter occurs, is very porous; so that, unless it were puddled, or a very considerable fall given, it would absorb the water very rapidly. Even if the main range were high enough throughout to render piping unnecessary, a fall of less than 4 ft. per mile would hardly be advisable, while even more might be allowed, as snow frequently stops the races cut by the miners, which, though very much smaller than the one in question, would have a much more rapid fall. This would make the water-source at least 120 ft. higher than the datum-point, and therefore 50 ft. higher than the point on the Doubtful reached by him.

The whole amount of piping to be done would be about 11 miles, chiefly embraced in the 4 gaps above mentioned; and allowing a head of only 8 ft. per mile to overcome friction, this would bring the source nearly 50 ft. higher still, or 170 ft. above the datum-point, and consequently 1¼ mile nearer the head of the stream than the place at which he left off. This would naturally reduce the volume of water available, and the chances of its being permanent in all seasons, very much. He was informed by some of the residents of Kiandra that the supply might, if necessary, be augmented by cutting a canal from the Burrungubugge river, which rises on the E. face of the main range, and about 2 miles farther S. than the Doubtful, to the Snowvale Gap, where the two races could meet.

Owing to the elevated position of the Nine-mile claims, he did not see any gully or basin within a reasonable distance which could be converted into a reservoir. The winter being so far advanced and the weather exceedingly bad, he was unable to level from the Nine-mile to Kiandra; but from observations taken with the barometer on two occasions, he estimates the latter place to be 550 ft. below the former; and as the gap in the Dividing Range between these localities is 330 ft. below the Nine-mile, a race could be constructed over it to Kiandra. The number of men at present employed in mining in the vicinity of Kiandra is very small, on account of the insufficient supply of water, derived almost entirely from the melting snow, so that they are compelled to work during the worst part of the year, almost the only time in which the races are of use; but there is no doubt that if hydraulic power were available, there would be profitable work for thousands of miners, as in fact the deep ground, which extends over many square miles, may be said to be as yet untouched.

More recent details concerning the Nine-mile Creek and New Chum Hill portions of the Kiandra diggings are given by Fred. B. Gipps, in a report dated May 9, 1881, from which a few extracts may be taken.

The geological character of the country is chiefly associated with granite and gneiss in the highest peaks and ridges, at times giving place to or flanked by serpentine, and the Lower Silurian slates, at times exchanged for basalt, which, overflowing from its submerged vent, has overspread the main dividing range of the Snowy and Murray river watersheds, and their spurs for many miles. Underneath this cap of basalt, lie the deep gravel-drifts which form the great mining wealth of Kiandra, and would appear to be almost inexhaustible for many generations.

The commencement of these drifts he traces to the Pliocene, or ancient eroding period, which followed the great upheaval of the mountain ranges. Then, as at the present time, different actions of the elements, more especially intense cold, split up and disintegrated the exposed masses of granite, slate, and serpentine, and the snows and storm-waters conveyed them to the valley below, whilst abrasion in their transfer and in the water-course gradually rounded them to their present form. Those valleys near their sources gradually assumed the appearance of large morasses, such as may be seen now on the western flank of Snowvale Gap, whilst the narrow outlet in many instances became choked, thus producing a lake, which, according to different seasons, was alternately full of water, or almost dry, and being subject also to great changes of temperature, and covered with dense vegetation, produced those conditions which formed the lignite beds. Gold, originally derived from granite, accumulated in thin flakes in the different water-courses, afterwards by the metamorphic action of pressure combined with intense heat (inducing hot springs with silica or magnesia in solution), it was disseminated through the serpentine and schistose rocks. From these rocks, it was again detached by erosion, and borne to its present gravel-beds.

The assumption that these drifts belong to one large river-bed appears to him improbable, chiefly because of the irregularities of the grade, and the varied character of the gravel-drift in different localities. A careful observation rather inclines him to think that they are feeders of the present river system, which have been first choked up as described, and afterwards preserved in that position by the great flow of lava which succeeded the Pliocene period. The flanks of the spurs which then bounded these basins, or gravel-drifts composed of serpentine and the Lower Silurian slates, having since been eroded away, have in their turn become water-courses, whose ancient beds are now elevated into spurs and ridges.

In considering the present and prospective value of the Nine-mile Creek diggings, he is of opinion that the original valley trended from the mountain towards Scott's Gully, following the course of the present ridge; and that the rich shallow alluvium in its immediate vicinity has been distributed from its gravel-drift. Accordingly, there is every probability of very rich gravel being discovered by continuing sluicing operations towards Mount Tabletop, as this portion has been protected from erosion by the flow of basalt on its southern flank. He compares it to the "blue lead" and similar gravel-drifts near Placerville, and other portions of California.

The section of the centre portion of the drift is given by Gipps as follows:—

	Ft.
Dark-brown surface soil, mixed with floating boulders of basalt, and large blocks of concretionary quartz cement, containing gold	7
White and grey clay bands	20
Brown-coloured lignite	18
Sand	3
Fine drift composed of small quartz and slate pebbles, seamed with thin layers of iron-stone cement, containing gold	65
Coarse drift composed of big boulders of quartz, jasper, and iron-stone (denoting a swift large stream on the bottom of the original valley), containing gold	6
	119

At base, is a soft rotten Silurian slate seamed with quartz and iron-stone. This measurement gives a total depth of 119 ft., of which 78 is auriferous.

The drift taken as a whole is of a very favourable character for hydraulic sluicing. It has none of the great difficulties to be met with in some deep leads, where occur two thick seams of basalt, which, when undermined, tumble down in large blocks, occasioning a great loss of time to remove out of the way; it appears to disintegrate easily, and, with the exception of the lignite and a few of the heaviest of the boulders, to be easily disposed of by the present limited method of sluicing. With a water-supply of 6,000,000 gal. daily, under a pressure of 140 ft. or 60½ lb. per sq. in., he estimates that at least 1500 cub. yd. could be sluiced away per diem. Taking the yield per cub. yd. at only 10 gr., value 1*s.* 6*d.*, the yield per diem would be 112*l.* 10*s.*, amounting to 28,350*l.* per annum of 252 days which would allow 10 weeks for washing up the tail-race, and for stoppages. The working expenses should not exceed 2350*l.* The area sluiced away every year by this estimate would amount to about 2½ acres.

The gravel in the New Chum diggings is coarser than that in the Empress, and, being associated with serpentine rock, should in Gipps' opinion prove to be richer. The workings affording reliable data for estimating the probable value of the gravel are those of the Emperor mine, where 1600 tons were crushed for a return of 50 oz., 80 tons for a return of 3 dwt. per ton, and 100 tons for a return of 3 dwt. per ton. It has been estimated that, owing to the intense cold preventing the amalgamation of the gold and mercury, at least one-half of the gold from the largest parcel was lost, and that the tailings realized as much more as the actual return. Considering the circumstances under which the crushing took place, when, owing to the intense cold, the mercury-boxes and blanket-tables must have been quite ineffectual for saving gold, and considering also that previous and later crushings of 80 and

100 tons gave an average of 3 dwt. per ton, Gipps believes that he is not exaggerating the value of the whole bank of drift, 115 ft. deep, in estimating it at 10 gr. or 1*s.* 6*d.* per cub. yd. The water available for hydraulic sluicing would not exceed an average of 4,000,000 gal. daily, which, with a pressure of 120 ft., would dispose of 800 cub. yd. per diem ; this, at 1*s.* 6*d.* per cub. yd., would yield 15,120*l.* per annum of 252 working days, allowing 10 weeks for cleaning up the tail-race, and for stoppages.

In considering the different schemes for supplying the mines with water for hydraulic sluicing, he concludes that the Empress mine, from its great elevation, can only be supplied by a combination of ditch and pipe conduits at a heavy expenditure. Doubtful Creek, rising in the Bogany mountain, is the only large water-course available, from which, in a direct line (S.), it is about 14 miles distant. He computed its delivery at 8,000,000 gal. daily. He estimates that it will require a flow of at least 10,000,000 gal. per diem at the source, to supply 6 at the terminus, the balance being required to account for soakage, which, in the open ditch through the rocky granite country, would be excessive. He therefore recommends a storage reservoir in Doubtful Valley, which, with a dam 50 ft. high and 550 ft. long, would impound nearly 500,000,000 gal. of water, thus ensuring a full supply all through the year, even for the most prolonged drought. By extensive surveys, he succeeded in reducing the length of conduit from 30 miles, as estimated by Sullivan (see p. 507), to 22 miles, only 7 requiring pipes.

Lachlan district.—Warden Dalton, in the Annual Report of the Department of Mines for 1877, refers to the neglected deep leads on the Lachlan gold-fields, around Forbes, the gutters of the several leads having all been hastily worked to the deep and wet ground and there abandoned. The smallness of the claims prevented the application of the machinery and plant necessary to enable the holders to contend with water, quicksands, and swelling schists with any prospect of success. With such imperfect appliances as were used in shallow and sound ground, the miners had no thought of reef-wash or benches, and when they had broken into the adjoining claim and sent up the last bucket of wash from the gutter, they abandoned their holding. Besides, miners in those days, who knew that they had wash before them that would yield ½ oz. or 1 oz. of gold to the bucket, would not willingly lose time in sending stuff to the surface that would not return more than 1 oz. to the load. In every instance, there was a strenuous effort made by each party to get their share of the gutter worked out before that of the adjoining shareholders, fearing that if these men were worked out, and abandoned the lead before they had secured the best of their wash-stuff, they would lose it, as they knew that single-handed they could not cope with the water and other obstacles that overlay the auriferous drift. These difficulties, in an aggravated form, present themselves to small co-operative companies without capital at the present day. The leads are not exhausted—the reef-wash, benches, and tributaries are still virgin ground—a channel in the older Tertiary drift crosses the richest portion of the gold-field, and must in ancient times have received the local drainage, while the discovered leads were in all probability tributary to it. Knowing all this, men hesitate to face ordinary mining difficulties that are of common occurrence in other parts of the world, and are invariably overcome by skilful engineers and the application of capital.

As a proof of the hasty manner in which the Lachlan leads have been run over, in the face of an accumulation of engineering difficulties, it is only necessary to state the time occupied in the work. About January 1862, a few rich claims in the alluvial flats at the base of the ridges on the N. bank of the Lachlan river had been discovered, and were soon proved to be the head of the first lead worked in New South Wales; within 4 months, 28,000 persons were encamped where Forbes now stands, and a modification of the frontage system had been introduced.

The original discovery was named the North lead, and its continuation to the river Lachlan the South lead, and upon the latter, at depths of 110 to 150 ft. progressively, 82 claims consecutively struck payable gold; at the same time, patchy and irregular leads were opened on the opposite or eastern side of the granite dyke, which, running N. and S., appears to have altered, fractured, and silicified the Silurian grits, sandstones, limestones, and chloritic slates and shales interstratified upon its flanks. The head of the North lead had been lost amongst the ridges, where a shaft had been sunk to a depth of between 300 and 400 ft., and no bottom reached; and by the 30th of June, 132,933 oz. 5 dwt. 3 gr. of gold had been transmitted to the Mint by escort; and up to the 31st December, an additional quantity of 102,110 oz. 11 dwt. 10 gr. was forwarded to the same destination by the same means, making a total of 235,043 oz. 16 dwt. 13 gr. for the year. By Christmas Day, 1862, the population had decreased to 12,000.

During the ensuing half-year, ending on the 30th June, 1863, 50,818 oz. 19 dwt. 22 gr. of gold were forwarded to Sydney; and the population on the Lachlan gold-fields was further reduced to 3500, including those engaged in working auriferous quartz reefs on distant outlying gold-fields. Dalton does not believe that at any time more than one-sixth of the people were actually occupied in mining operations. The remainder was made up of speculators, traders, mechanics, professional men, women and children, and camp followers. In June 1863, the gold-fields of New Zealand became the centre of attraction, and the miners on the Lachlan, unable to resist the wealth of the Shotover, migrated by thousands. It is thus evident that the Lachlan gold-fields could not have been effectively worked in 18 months, and that, notwithstanding the enormous yield of 285,862 oz. 16 dwt. 15 gr. of gold within that period, the deep leads could not have been tested. Not a single lead has been traced to its termination, nor farther than could be done by unassisted manual labour.

The Madman's, Grasset's, and other very short but rich tributaries to the most productive portion of the South lead, have been found to have their source in an altered gritstone dyke or belt that extends due north from the Britannia reef; some very rich patches of gold-bearing quartz have been found in leaders or veins, interlaced with this altered rock, and Devonian or Upper Silurian fossils in abundance have been also found in a similar formation, but of a finer grain, in the vicinity. This grit, in contact with granite, crops up on Thompson's Hill, 2 miles farther N., and wherever it has been found on this gold-field, the yield has been extremely rich; that this dyke contains the gold is beyond doubt, as it has been obtained from the rock *in situ* from several parts at long intervals of distance. Situated not more than 300 yd. from the South lead, on its W. bank, and nearly parallel to it, and having a N. strike, it has not been followed. Some of the water along the line of strike is as salt as brine, while at the same level and at no great distance it is found pure and fresh.

In a letter (Dec. 27, 1877) addressed to Dalton, Philip Davies states that he is possessed of abundant evidence from reliable miners, as well as his own observations, which convinces him that only an infinitesimal part of this ancient river-bed was worked in the early days—and owing to the great amount of water there was to contend with, no mining has been carried on to any extent ever since—and, with much confidence, gives it as his opinion that the whole of the old workings on the South lead, from its source to the place where it intersects the present Lachlan river, would, by re-working by steam-power, turn out immeasurably more gold than was realized in the time of its prosperity. He considers it of the greatest importance that the mining community should be reminded that immense deposits of rich gold-bearing wash-dirt have been discovered in Victoria on the sides and ledges of deep leads. It is well known that only a small proportion of the gold won from the deep alluvial mines of Ballarat was taken from what is termed the lead proper, the "deepest channel"; but by far the greatest quantity of gold was subsequently found to have lodged on either side of the ancient river banks—what is familiarly termed in the deep alluvial districts "reef-wash."

As the deep leads of Forbes have already proved evenly rich, as well as regular and defined in their deposits of gold-bearing wash, in the deep ground, it is quite fair to conclude that the banks of the deep leads will be found to contain immense fields of gold-drift of like deposit, which were entirely overlooked by the early miner; indeed, the surrounding geological features of Forbes strongly argue in favour of the existence of such reef deposits, and particularly favour this theory as regards the west bank of the South lead, because of its close proximity to the gritstone dyke, where the well-known Britannia quartz lode exists. The detritus from this auriferous band of rock has formed three tributary gutters to the South lead, viz.—Madman's, Grasset's, and the Britannia. These rich tributaries have only been imperfectly and partially worked, like the main lead; but he feels certain that the whole of the western bank of this ancient river, as well as the banks of the tributaries, will yet produce immense quantities of payable wash-dirt.

Mount Werong.—This site of one of the recent gold discoveries was reported on by Lamont Young, on October 2, 1880. His remarks are substantially as follows:—

Mount Werong is situated in the parish of Werong, county of Georgiana, close to the Main Dividing Range of the colony, which at this locality forms the boundary between the counties of Georgiana and Westmoreland. The summit of Mount Werong is the highest point in the neighbourhood, and it has therefore been chosen as a station by the Trigonometrical Survey, and a small reserve made round it.

The geological formations of the locality are slate, granite, and basalt, the first-named composing the main mass of the country, and being intruded by dykes and masses of granite, while the summit of Mount Werong is composed of basalt. Over the slate and granite formations, and even in places situated on the top of the main range, is spread a considerable amount of alluvion, composed chiefly of sand, clay, and rounded quartz pebbles, the latter varying in diameter from 4 in. to $\frac{1}{8}$ in. It is in this alluvion that the gold is found, and so evenly distributed that as good a prospect can often be got on the top or side of a ridge as in the gully below it. The prospects hitherto washed have yielded from a colour to $\frac{1}{2}$ gr. to the dish; and sluicing has given in one locality a return of 10 dwt. for 8 loads.

The gold as yet found is very fine, of a dark colour, and, examined under the microscope, appears more or less water-worn, some pieces being almost perfectly round. Associated with the gold are zircon (both white and red), sapphire (blue and green), pleonaste, a black variety of spinel, and quartz. One or two of the gold specks contained imbedded portions of quartz. The prospectors, Murdock and party, showed him a portion of a small quartz leader highly impregnated with iron-pyrites, but in which no free gold could be seen. The specimen was found in the locality.

A noticeable feature at Mount Werong are the swamps and springs; and when considered in connection with the large rounded quartz pebbles found at M'Kay's claim, the fact of the gold being water-worn, the widely-scattered nature of the alluvion, and also that the highest ground in the neighbourhood is an inconsiderable mass of basalt, the conclusion indicated is that an old lead has existed in the locality, formerly covered with basalt, which has since been removed by denudation, while the contents of the lead have been spread over the adjacent country. Should any portion of the gutter of this old lead be discovered intact, payable gold will most likely be found.

The following parties were working at the time of Young's visit:—

Munn's had washed 8 loads, with a yield of 10 dwt.; bed-rock, granite; sinking, 2 to 17 ft., and very wet.

Creighton's had been 1 month on the diggings, and only got a few colours; sinking, 11 ft.; bed-rock, granite; ground very wet.

Prospectors are sluicing the bed of a gully; bed-rock, slate, but 50 yd. up it is granite; alluvion, 2 to 5 ft. deep; gold colours can be got all over adjoining ridges.

M'Kay's claim is traversed by the surveyed line along the Main Dividing Ridge; sinking, 23 ft., but the deep ground has not yet been struck; bed-rock, granite; 3 ft. of wash, expected to yield $1\frac{1}{2}$ dwt. to the load.

Tallawang gold-field.—During Wilkinson's examination of the Tallawang gold-field reserve, in November 1876, he observed the important fact that the gold found in the Tertiary alluvial deposits at the Old Tallawang and Clough's Gully diggings has chiefly been derived from conglomerates in the coal measures. These conglomerates are associated with beds of sandstone and shales containing the fossil plant characteristic of the New South Wales coal measures, the *Glossopteris*. At Clough's Gully, the conglomerate *in situ* is being worked, and yields 1 to 15 dwt. of gold per ton, and nuggets weighing up to 5 oz. have been obtained from it. Several hundreds of tons of the conglomerate (locally termed "cement") have been crushed; but as the yield is said to have been "patchy" or variable, work has been stopped, and the ground is now held under lease. There are, however, a few miners still at work in the adjacent claims, and Wilkinson took the opportunity of purchasing from one of them a sample, weighing 1 oz., of the gold, which he was crushing by hand out of the hard cement. The gold is coarse in size, remarkably scaly, and water-worn. R. M'Kay, of Clough's Gully, gave him one small piece of the conglomerate showing coarse gold. This is the first time that gold has been noticed to occur in payable quantity in the coal measures in the colony: and it is not unworthy of remark that this constitutes one of the most ancient auriferous "alluvial" deposits in the world. It affords additional testimony to the researches of the Rev. W. B. Clarke, who, many years ago, ascertained the occurrence of gold in minute quantity in the Hawkesbury Rocks, at the North Shore, Sydney, at Govett's Leap, and in the conglomerates of the coal measures in the Southern district, in which latter formation Sir Thomas Mitchell also found a speck of gold in a pebble of quartz. Gold is also stated to occur in the coal measures at Peak Downs in Queensland; near Hobart Town, in Tasmania; and in New Zealand. But apart from the scientific interest attaching to the subject of the geological age of auriferous alluvions, the fact that gold in payable quantity has been proved to exist in the coal measures is one of considerable importance; for it may lead not only to the working of some of the conglomerate beds at the Old Tallawang diggings, but also to the discovery of other similar auriferous patches, which no doubt occur in the Tallawang gold-fields and in other parts of the colony, where the same geological features are presented. Amongst a collection of the Tertiary vegetable fossils submitted to Baron Ferd. von Müller, were discovered 7 genera and 9 species of plants new to science. Most of these fossil fruits were found beneath basalt, at a depth of 160 ft. from the surface, in No. 23 claim, Black Lead, Gulgong.

Temora gold-field.—Lamont Young's report on this gold-field, dated September 6, 1880, is mainly as follows.

The township of Temora is situated in the parish of Bundawarrah, county of Bland, and between the Trigalong and Narraburra Creeks, the first-named lying 2 miles to the W., and the second 5 miles to the E. These creeks are merely depressions in the alluvial surface of the country, and trees grow in the deepest portion of their channels; at times, however, the banks are well defined, and the erection of a small dam will throw the water back a considerable distance.

The principal geological formations in the district are Silurian slates and conglomerates; near the Temora sheep-station these rest against granite, and at the township itself against a long hill of diorite (or greenstone) running N. and S., and adjoining the auriferous alluvion on the E. To the N.E., E., and S.E. of the diorite, is a belt of altered rocks, and beyond these the slate formation.

The auriferous alluvion at Temora fills a deep and narrow valley draining between the slates and the diorite in a N. direction. In both these formations, are numerous quartz reefs, but gold has only been found in those occurring in the diorite; reefs also occur in the altered rocks to the E., and one or two of them have been reported gold-bearing. The length of the lead known to be auriferous may be set down as 2¼ miles; its character as far as it has been proved shows that the gold is chiefly coarse, and irregularly distributed; also that it is of a light colour, and as a rule very little water-worn. Near the upper township, the lead divides into two branches, one crossing the diorite in an E. direction, and the other continuing to skirt it on the W. No gold discoveries of any consequence have yet been reported in the alluvion to the S. of the diorite; but some rich surfacing has been got on the S.W. slope of the diorite hill at the upper township, immediately below the Lady Mary, Warnford's, and other reefs. These facts indicate that the reefs in the diorite are the source of the alluvial gold that has been found as yet. Young is therefore of opinion that the lead will only be payable in the vicinity of the diorite, and that rich surfacing and leaders will be found near the Ironclad, Red Hill, Eldorado, Hidden Star, and other reefs. These reefs may themselves be worth working, but he thinks will vary considerably in width, extent, and gold-bearing qualities. Should other outcrops of diorite be found in the district—and there is every likelihood of such being the case—the old drainage-channels crossing them may be expected to be auriferous in the immediate vicinity. There is one fact which is favourable to the discovery of gold-bearing reefs in the slates and conglomerates, namely, that it is in these very formations that the valuable reefs of Barmedman occur, situated some 28 miles N. of Temora.

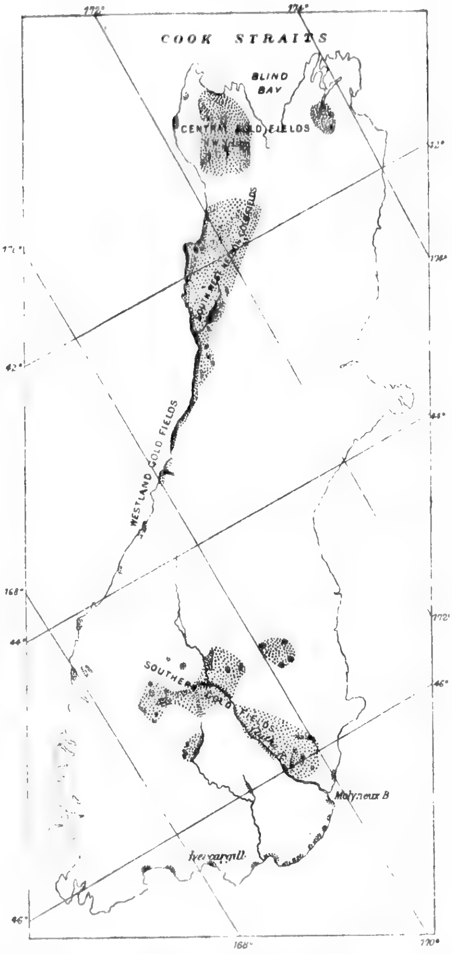
From such tests as have been applied, and by comparing the local conditions with those of other and similar gold-fields, such as Gulgong, Forbes, &c., it may be anticipated that the alluvial deposits (so far discovered) of Temora will be worked out in about 5 years, and that as a reefing district it will furnish employment to miners for a considerably longer period.

Such are the prospects of this gold-field, as indicated by its geological features and the practical tests as yet applied; but it is impossible to form an estimate of the richness of its alluvial deposits until a few thousand loads have been washed. At present, as stated in Warden Sharpe's report, there is a considerable quantity (some 60,000 loads) of wash-dirt on surface, but unfortunately no water with which to treat it. This want of water prevents also the thorough prospecting of the neighbouring country.

NEW ZEALAND.—Gold was discovered in New Zealand in 1842, less than 3 years from the foundation of the colony, but it was not practically worked until 1852, when the mines at Coromandel first attracted attention to the district of Cape Colville peninsula, which at the present time forms the chief seat of true mining operations in New Zealand. The yield from those mines has up to the present time been over four and a half millions sterling, but is small when compared with the quantity of alluvial gold obtained in the South Island, subsequent to 1861, at which date the gold-fields of Otago became prominently known.

The principal quartz mines in the North are in Coromandel and in the Thames districts, about 30 miles apart. In these localities the reefs have been "proved" to a depth of over 600 ft. below sea-level; but the best mines have as yet been principally confined to the decomposed and comparatively superficial rock. Veins have been discovered, and gold obtained, at all levels on the ranges, from the sea-level to an altitude of 2000 ft. The quantity of gold that has been obtained from some of these quartz reefs is very great; and for considerable distances the quartz has

FIG. 20.



SKETCH-MAP OF NEW ZEALAND GOLD-FIELDS (MIDDLE ISLAND).

yielded very uniformly, at the rate of 600 oz. to the ton; such reefs are, however, very exceptional in New Zealand, as elsewhere.

Auriferous reefs are also extensively worked in the schistose rocks of Otago, and they occur at all altitudes, from sea-level to 7400 ft., the most elevated gold-mine in the Australasian colonies being that opened during 1878 on the summit of Advance Peak, near the Wakatipu lake.

Several promising reefs have also been found in the Westland gold-fields, amongst which may be mentioned a reef of auriferous stibnite at Langdon's Creek, near Greymouth, which yields from a few oz. to 99 oz. of gold per ton; but up to the present time, these reefs have not received the attention they deserve, except at Reefton and a few other localities. The importance of Reefton as a well-established mining district may be judged of from the fact that 9 mining companies there, during the single year ending 31st of March, 1878, divided, as profit, the sum of 63,508*l.* among the shareholders.

So far as this more permanent form of gold-mining is concerned, there is every reason to feel confident that it is still in its infancy in this colony, and that it only awaits the judicious application of capital for its development to a vast extent.

Alluvial gold is chiefly found in the South Island, in the districts of Otago, Westland, and Nelson, in which mining operations are carried on over an area of almost 20,000 sq. miles. The auriferous sand, or gold-drift, as it is usually termed, is of three distinct kinds:—

1. That which is found in the beds of rivers, and which is worked by small parties of miners, as the process requires no large expenditure of capital to effect the separation of the gold.

2. Immensely thick deposits of gravel of more ancient date occupy the wider valleys and the flat country, from which the gold can only be obtained by means of considerable expenditure and large engineering works for the purpose of bringing a supply of water for undermining and working the auriferous deposits. This description of mining is of a more permanent character than the former, and provision has been made by the Colonial Government for assisting the miners by the construction of water-races, which will supply the means of profitable employment to a much larger number of persons than at present gain a livelihood.

Some of these deposits are of considerable age, the cements of Tuapeka being certainly not younger than the lowest Tertiary deposits of the colony. They occur in beds 300 to 500 ft. thick, and cover a considerable area of country. This cement is treated in a different way to ordinary alluvial deposits, being crushed and washed in the same manner that a quartz reef is worked; but, in consequence of the nature of the deposit, about 150 tons of stone is thus put through the batteries in one day. It consists of coarse gravels and silts cemented together, and carrying variable quantities of gold, and was first found at the Blue Spur in Otago, and subsequently at a number of other places in the same district; at Charleston and elsewhere, on the W. coast, auriferous cements are also worked, but the localities first cited are those which to the present time have received the greatest attention. The yield of gold from cement claims is small, but in consequence of the large amount of material which can be operated upon, the value of such deposits is considerable, and their extent guarantees that they will afford a remunerative return to those who are working them for some time to come.

3. Along the sea-coast the continued wash of the waves produces a shifting action on the sands which are brought down by the rivers and drifted along the shore, thus producing fine deposits of gold, which, by the aid of simple mechanical contrivances, afford employment to a large number of diggers, who can labour without incurring the hardships and privations which attend their occupations in the more inland districts.

The alluvial diggings at Collingwood were discovered in 1858; those of Otago in 1861; and in 1864, the gold-fields near Hokitika proved a great attraction to the mining population of New Zealand. In Otago, the gold-drifts rest on the denuded surface of their parent rocks. The auriferous gravels in the W. district, on the other hand, as a general rule, rest on the surface of Tertiary rocks of marine origin, and they have a general distribution parallel to whatever was the W. shore of the island at the time of their deposit.

The richest alluvial diggings in Westland usually occur in places very inaccessible for water-supply, the streams having cut their channels much below the surface of the country, so that an organized system of irrigation is necessary to obtain the required amount of water for gold washing.

The following is the composition of the New Zealand gold as exported from various parts:—

Melted gold from West Coast, Hokitika, Westland:

			oz.	dwt.	gr.
Assay—Gold	·9627	= Fine Gold	9	14	16
Silver	·0363				
Copper	·0010				

Weight, 10 oz. 2 dwt. 6 gr.

Melted gold from Thames District, province of Auckland:

			oz.	dwt.	gr.
Assay—Gold	·6565	= Fine Gold	6	12	18
Silver	·3390	= Silver	3	8	13
Copper	·0045				

Weight, 10 oz. 2 dwt. 6 gr.

Refined gold, as extracted by chlorine refining process, and as exported by the Bank of New Zealand, Auckland:

			oz.	dwt.	gr.
Assay—Gold	·9942	= Fine Gold	9	19	20
Silver	·0058				

Weight, 10 oz. 1 dwt.

The gold-yielding formations of New Zealand, as compared with those of Australia, are thus given by Dr. Hector :—

NEW ZEALAND.	AUSTRALIA.
Recent, alluvia.	Newer gold-drift of Victoria.
Pliocene, shingle plains.	Older gold-drifts and deep leads of Victoria.
Lower Miocene, Ross beds.	——
Cretaceo-Tertiary, coal formation.	——
,, ,, propylite breccias.	——
Lower Carboniferous, Maitai slates.	——
(?) *Upper Devonian*, Te Anau beds.	——
Upper Silurian, Batow river slates.	——
Lower Silurian, hornblende rocks.	Auriferous slates of Victoria.

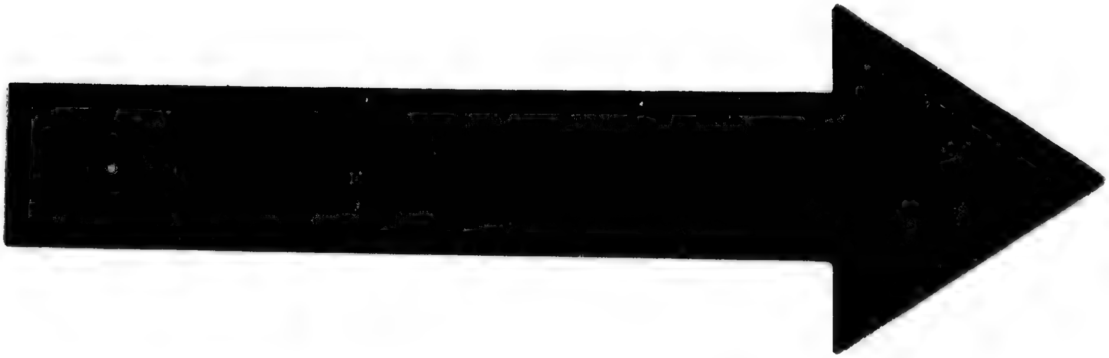
The following observations are gathered from James McKerrow's report on the gold-fields of New Zealand for 1881.

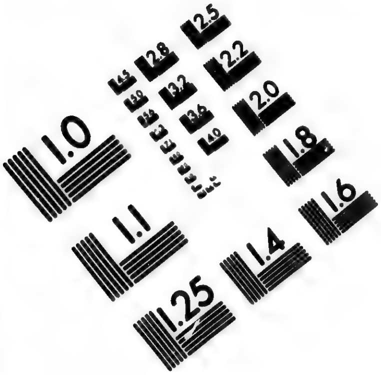
On the gold-fields of New Zealand during the past year (1880) there has been more than usual activity. This has been most prominently displayed in the prospecting of new country, and in the increased area of proved auriferous ground which has thereby become known.

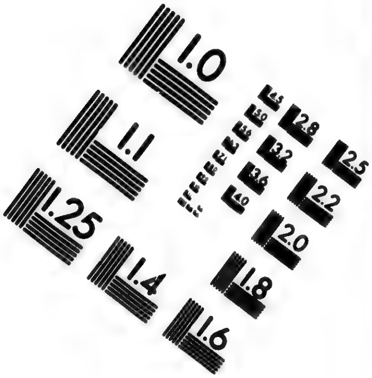
Te Aroha and Coromandel in Auckland province, Mohaka in Hawke's Bay, Terawhiti in Wellington, Mount Arthur in Nelson, and head of Lake Wakatipu in Otago province, are localities in which more or less has been done in the discovery and testing of auriferous quartz veins. As frequently happens in quartz mining, there were at first in most of these cases greater expectations than subsequent experience has yet realized. It requires an expenditure of much hard work, time, and money before even the richest mine can be rendered productive. This necessary outlay is being made at most of the places named. In the alluvial mining districts of West Coast and Otago also, new ground has been explored; and in old ground, improved machinery and more tunnels and sludge-channels have been brought to bear on deeper deposits.

These prospectings and preliminary works have not been done to the neglect of workings formerly opened out, as the increases under the various heads of revenue show, as also the considerable increase in the yield of gold in 1880 over 1879, in the following comparative statement :—

	1879.		1880.		Decrease.	Increase.	
	oz.	£	oz.	£		oz.	£
Auckland	37,901	154,295	42,720	176,416	..	4,819	22,121
Marlborough	879	3,460	1,550	5,650	..	671	2,190
Nelson	2,993	11,424	3,222	12,223	..	229	799
West Coast	142,822	571,061	144,090	575,258	..	1,268	4,197
Otago	102,869	407,868	113,666	457,705	..	10,797	49,837
	287,464	1,148,108	305,248	1,227,252	..	17,784	79,144
Increase for 1880						17,784	79,144







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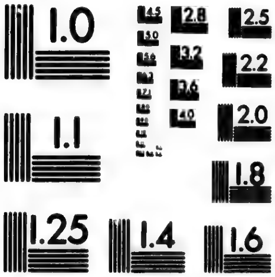

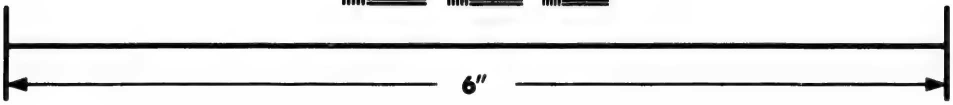

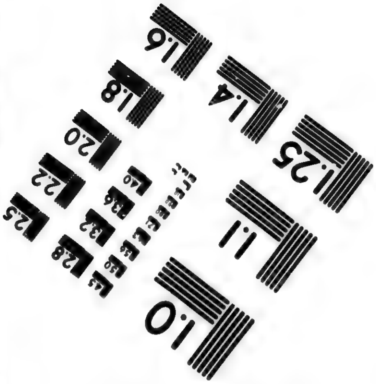

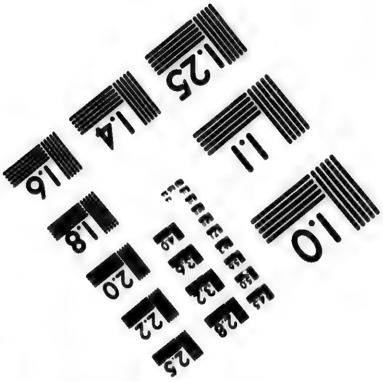

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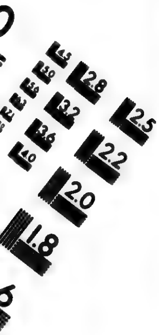
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Comparison of the quarters ended March 31, 1880 and 1881, shows, on the other hand, a very great falling off for the first quarter of the current year. As explained in former reports, the only criterion of the yield of gold is in the quantity passed at the Custom-house for export. This, of course, takes no account of what is used up in the colony, which may be taken to vary from 10,000 to 20,000 oz. a year. Nor for so short a period as 3 months, can any very reliable conclusion be come to as to the actual yield of the gold-fields during that time, there being many contingencies which affect the quantities sold by the miners and shipped by the banks, which do not recur regularly within a 3 months' period, but which adjust to a much better average for a period of 12 months.

	1880.		1881.		Decrease.		Increase.
	oz.	£	oz.	£	oz.	£	
Auckland	11,787	47,403	6,151	23,779	5,636	23,624	..
Marlborough ..	215	850	..	..	215	850	..
Nelson	1,096	4,129	250	1,000	846	3,129	..
West Coast	33,615	134,426	23,822	95,286	9,793	39,140	..
Otago	32,589	131,400	20,418	82,167	12,171	49,233	..
	79,302	318,208	50,641	202,232	28,661	115,976	..
Decrease for 3 months ended 31st March, 1881 ..					28,661	115,976	..

Statement of Gold Exported and Value for the years, as under.

Year.	oz.	£	Year.	oz.	£
1857	10,436	40,442	1870	544,880	2,157,585
1858	13,533	52,443	1871	730,029	2,787,520
1859	7,336	28,427	1872	445,370	1,730,992
1860	4,538	17,585	1873	505,337	1,987,425
1861	194,234	752,657	1874	376,388	1,505,331
1862	410,862	1,591,389	1875	355,322	1,407,770
1863	628,450	2,431,723	1876	318,367	1,268,559
1864	480,171	1,857,847	1877	371,685	1,496,080
1865	574,574	2,226,474	1878	310,486	1,240,079
1866	735,376	2,844,517	1879	284,100	1,134,641
1867	686,753	2,700,275	1880	305,248	1,227,252
1868	637,474	2,504,326	1881	270,561	1,080,790
1869	614,281	2,362,995			
				9,815,791	38,435,124

The number of miners on March 31, 1881, was 15,063, and as the number 12 months before that was 14,409, the mean number for the year will be 14,736. The gold exported for the same period was valued at 1,111,276*l.* This does not include the gold used up in the colony; but excluding this uncertain quantity, and simply taking the export alone, as was done in former years in striking the average earnings per man, it will be found that this is 75*l.* 8*s.* for the 12 months ended March 31, 1881. For the 3 preceding similar periods, going back, the average earnings per man were respectively 81*l.* 2*s.*, 75*l.* 10*s.*, and 97*l.* 10*s.*, or for the 4 years—31st of March, 1877, to 31st of March, 1881—an average of 82*l.* 7*s.* 6*d.* per man. In Victoria, the average for the 4 years ended 31st of December, 1880, is 80*l.* 15*s.* per man. 82*l.* 7*s.* 6*d.* a year, or 1*l.* 11*s.* 8*d.* a week, would be a low average wage for men residing in a colonial town; but the miners, more especially the alluvial miners (and they greatly preponderate in number), reside in the vicinity of their workings, rent free, and, if they choose, on a residence area of one acre. On the W. coast and at the Thames, firewood is abundant; and in Otago, there are lignite deposits side by side with the gold.

Subject to regulations, there are more than 10,000,000 acres of Crown lands over which the miners have the right to search and mine for gold, and to occupy whatever portion they may select for mining or residence purposes. For these privileges, there is the annual payment of 1*l.* for miners' right, 1*l.* an acre of rent for ground held on mining lease; also registration fees of water-rights and other mining property, which are almost nominal; and the gold export duty of 2*s.* an oz., which, although not paid by the miners directly, is none the less so indirectly. These various items amount to an average contribution per miner of about 3*l.* a year, or a total of 49,000*l.* for the year.

The collection of this revenue and the expense of administration of the gold-fields is at the sole charge of the Government, but the revenue collected is paid over to the funds of the county within which it arises. Many of the miners have entered into farms or have interests in cattle, and still prosecute mining for a portion of the year at least. The search for gold has been the occasion of leading men into the country, and the result has supplied them with the means of settling it. There is a great deal yet to be done in this way, more especially on the W. coast of the Middle Island, where are extensive districts that, as they get opened up by roads, will afford thrifty men the opportunity of settling down and drawing on the auriferous deposits from time to time. All along the coast-line, from Cape Farewell to Milford Sound, are to be found hardy pioneers who, in pursuit of gold and adventure, have settled down in some favourite spot, and in their independent mode of life find a charm which more than compensates for its solitude and isolation.

Fully two-thirds of the year's return of gold was obtained from alluvial mining, and the balance from quartz and cement crushings. The returns from these two classes of mining have maintained about the same proportion for several years. The vast extent of the auriferous gravels, extending as they do in the valleys and terraces over an area of country of upwards of 10,000,000 acres, will maintain the pre-eminence of this class of mining in New Zealand for many years to come. Water for sluicing and washing the deposits is an indispensable requisite in alluvial mining, and that is always attainable in abundance in the natural supplies of the country. The extent to which this has been availed of is manifest in the statistics, from which it appears that upwards of 5000 miles of water-races have been constructed by the miners, at an estimated cost, with their attendant tail-races and dams, of nearly 800,000*l.* This is exclusive of Government water-races and dams, which cost 450,000*l.*

Ground-sluicing is the favourite mode of alluvial mining, and, with a plentiful supply of water and a good fall for tail-race, it is the most profitable and certain in its results, even in ground that would be far too poor to work by any other method. It is a most destructive process, for the claim being once opened out to the depth of the layer of auriferous drift, the water, with a head of 80 or 100 or more ft., is directed through a hoze and nozzle against the face of the claim, which it cuts into, undermining hundreds of tons of stuff in a few hours, which keeps falling in and is passed on in a muddy stream through the long line of tail-race, where the particles of gold settle by their gravity. In this way the crust of the earth is washed away to depths of from a few feet to over a hundred. The value of gold obtained from a sluicing claim varies from a few hundred pounds sterling to many thousand pounds per acre.

The magnitude of the sluicing operations soon destroys the natural fall of the tail-race by the accumulation of spoil at its lower end. Many expedients are had recourse to in order to overcome this difficulty. At Dilman's Town, Kumara, where are 340 acres of proved payable auriferous ground in one basin—being 2 miles of the ancient bed of the Teremakau—advantage has been taken of the lower level of the present channel of that river, by running tunnels from it through the intervening terrace formation to a level below the auriferous deposits. Through these tunnels the sludge flows in a rapid current from the claims, and is shot into the deep bed of the Teremakau. There are several private tunnels in operation, and the Government has a tunnel sludge-channel of 87 chains in length in course of construction, the lower half of which has been completed and timbered in a very substantial manner, and it can be availed of as soon as the claim-holders have made their branch tunnels into it. The section of this tunnel is 11 ft. by 7 ft. It may be compared, as in reality it is, to a gigantic underground sewer. It will cost over 14,000*l.* The open sludge-channel at Naseby is another large public work of this class; it is 8 miles long, and cost 23,492*l.* The conditions, however, for disposal of tailings are rarely so favourable as at Kumara and Naseby, especially at the former; and sludge-channels become impracticable where there is little fall. Recourse must then be had to the more expensive and laborious process of tracing the auriferous ground by tunnels, and raising it up a shaft to a platform sufficiently high to allow of fall for the tailings after the stuff is washed. This plan is adopted with great success at Orwell Creek, Ahaura.

But the most ingenious expedient for overcoming the tailings difficulty is in operation at Gabriel's Gully, Tuapeka. In that gully is an accumulation of millions of tons of tailings from the earlier workings of the famous Blue Spur. This mass of stuff, and portions of the original ground on which it rests, have long been supposed to be payable if they could only be put through the sluice-boxes in a wholesale manner. There is plenty of water available, but not sufficient fall. The problem seemed insoluble until J. R. Perry took it up. By his plan, the stuff is forced up a pipe by a powerful jet of water let in from a nozzle at the lower end of the pipe. This jet has a head of over 300 ft., and so great is the suction induced by its ascent that as the stuff is fed into the lower end of the pipe by a stream of water it is at once drawn in and rushes up the pipe, and would be discharged at the top as from a catapult or volcano but for an iron hood which serves the double purpose of breaking any agglomerated nodules, and guiding the stuff within the sluice-boxes, along which it is carried by the water, and is shot over at a convenient distance from the workings. In this way the stuff, instead of being washed bodily away down a sludge-channel, is simply turned over and shifted a few hundred feet at most. A more detailed description of this ingenious plan will be found in Chapter V. It is a great mechanical success, and will pay, it is estimated, if the ground will only yield a few grains of gold per ton.

As another instance of the skill and enterprise at work in the development of the alluvial deposits, the dredging of the bed of the Clutha may be cited. For many years dredging-machines have been at work on that river. The principle and system of raising the stuff by a chain of buckets in these machines are almost identical with that of harbour dredges. They are moored on the river, the powerful current of which acting on paddle-wheels supplies the motive power which drives the buckets. The bed of the river being very rich in places, the dredging has proved profitable to many. But the dredger, depending on the current of the river for power, can only work where that is strong. Another plan was to have a punt or platform moored on the river, and by means of a large scoop with a strong canvas bag attached stuff was raised by a lever; this was a very laborious process. Another plan was on the pneumatic-tube principle employed in sinking cylinders for the piers of bridges. In it, the miner was let down and worked on the bed of the river direct. But there was too much time and expense involved in shifting the tube, and this plan was soon abandoned. There was also a plan of submarine boat on the principle of the diving-bell; the boat and apparatus were constructed, but the project fell through. The dredger principle is the one approved by experience, and there are now four steam-dredgers to be placed on the river. They, of course, will be independent of current, and will be able to work on any part, and should put through a great deal of stuff. This is essential to success, because the river-bed has become greatly filled up with tailings from former workings, and that waste has all to be lifted before the fertile ground on the original bed of the river is reached.

It has been found at Charleston that the gold does not all settle in the tail-race, but that on the union of the waters of several tail-races a small percentage, well worth saving, floats away on the stream. This is arrested by a series of blanket-tables placed across stream, like weirs, thereby causing the water to flow over all the tables in succession. The tables are washed in turn, and the gold streamed from the sand, and is caught up by mercury.

On the coast-line, about 2 miles N. of Charleston, is a colony of Shetlanders, who with their families have settled down in comfortable homes along the edge of the forest, and whose working time is divided between small farm cultivation and the washing of the fine gold from the sea sands, which, after certain weathers, are easily got at and found to be highly auriferous. These beach-claims are deemed valuable property, are kept carefully registered, and as much as 250*l.* has been paid for the transfer of the right to work a few square yards of what, to a casual observer, would only appear a flat patch of barren sand.

The returns from quartz and cement mining for the 12 months ended 31st of March, 1881, are—

	Tons of quartz crushed.	Oz. of gold.
Auckland—		
Coromandel	720	4,960
Thames	32,404	53,154
West Coast—		
Reefton	25,926	17,802
Lyell	6,880	5,675
Marlborough—		
Havelock	600	190
Otago—		
Cromwell	4,511	3,602
Arrow (Macetown)	4,896	2,254
Skipper's	3,752	915
Hindon	766	326
	80,455	88,878 from quartz.
Lawrence	..	25,600 estimated from cement.
		114,478 from quartz and cement.

The quantity of quartz crushed is 4000 tons greater than last year; this is entirely due to the Alpine Co.'s mine, Lyell, which, after a great deal of heavy preparatory work, has been crushing regularly for some time past. In the other districts, has been a slight falling-off. For the last 3 years, the returns from quartz mining have fluctuated very little, the total tons crushed being the same annually within 4000 tons, and the yield of gold within 9000 oz. These comparisons also bring out the fact that for 3 years the quartz-crushings of Auckland yielded 1 oz. 10 dwt. to 1 oz. 17 dwt. per ton; the W. coast, 13 to 18½ dwt. per ton; and Otago, 10 to 18½ dwt. per ton.

Comparing the quartz-crushings of New Zealand with those of Victoria, and taking the most recent annual returns, they are: New Zealand, 80,455 tons, 88,878 oz., or 1 oz. 2 dwt. 2 gr. per ton; Victoria, 968,883 tons, 466,404 oz., or 9 dwt. 15 gr. per ton.

The average yield of quartz crushed in Victoria for the 6 years, 1874–80, was 10 dwt. per ton on the vast quantity of 5,619,776 tons. In New Zealand, although the average yield of gold has always considerably exceeded 1 oz. to the ton, yet quartz mining has not made such progress as this statement might suggest. There is plenty of stone, but with the higher price of labour, and the difficult nature of much of the country, ½ oz. to the ton would not pay as in Victoria. The consequence is that stone is left untouched that would pay well if in the other colony. There are several ways in which quartz mining may be promoted in New Zealand. The most obvious are, especially in mountainous districts, (1) The opening of roads so that machinery and timber may be got on to the ground with moderate expense; (2) the granting of large areas in exceptionally difficult circumstances.

The wisdom of granting large areas has been strikingly exemplified in the history of the Alpine Co.'s mine, Lyell, already referred to. The mine is situate up a wild bush gorge 6 or 7 miles distant from the nearest point of the dray road; it is high up on the mountain side, and how to get machinery there and get the stone down to a site where the stampers could be erected was a problem requiring much skill and courage to solve. A large outlay was necessary, which the company saw would have been folly to incur on a lease of no greater area than the usual 16½ acres. The Government accordingly, 3 years ago, allowed an extension of area to 50 acres, and since then, by a large expenditure and much determination, the mine has become one of the most prolific in the colony. About the same time, the Welcome Co., at Boatman's, near Reefton, applied for an extension of area, so as to be enabled to drive through to some back country; after due inquiry, the application was granted; and the success of that mine, after a thorough and costly blocking out of the lodes, has been very satisfactory to the fortunate shareholders. There is plenty of stone in the colony, and similar success seems to await other companies that have the skill, capital, and patience to fairly test and open new ground.

In keeping with the policy of encouraging costly mining enterprises, a company at Ross, Westland, 7 months ago, was granted a lease of

100 acres, so as to warrant the heavy preliminary expenses of opening out the deep leads there; and likewise, the Rangitoto Silver Mining Co., also near Ross, after having expended many thousand pounds in prospecting the ground, has been allowed to acquire the freehold of 500 acres, with the object of enabling the company to raise more capital towards further development of the property.

Having dealt with the New Zealand gold-industry as a whole, some details may now be given of the chief gold-fields, in alphabetic order.

Otago.—In 1875, Professor G. H. F. Ulrich presented to the Otago Provincial Council, a most invaluable report on the auriferous quartz reefs and crushing machines of the province of Otago, with remarks on its auriferous drifts, which may be summarized in the following terms.

The Auriferous Reefs.—As introductory to the description of the reefs, the following remarks on the nature of the country-rocks in which the reefs occur, or gold has been found in matrix, will save frequent repetitions. With the exception of those of the auriferous locality near Portobello, specially considered farther on, the rocks consist throughout, according to Ulrich's observations, and which are confirmed by Captain Hutton the Provincial Geologist's more extensive and detailed geological survey—of metamorphic schist, i. e. argillaceous mica-schist or phyllite, changing from the E. towards the W. into real mica-schist, with subordinate bands of chlorite-schist, or chloritic mica-schist. The line or boundary where this change takes place has with difficulty been traced by Captain Hutton, but it appears that within the large district on the W., occupied by mica-schist, exists at least one rather large area, viz. the Carrick Range, where the rock conforms in all lithological respects to true phyllite, and this range lies, according to Captain Hutton, within the line of a main anticlinal axis, the existence of which he first established. Whether this inlying patch of phyllite represents a remnant of denudation of a once superincumbent general formation on the mica-schist, or whether it simply constitutes an area where the metamorphic action and change were of less intensity, remains a difficult problem, to solve by future investigation. Only at two places within the extensive metamorphic district Ulrich obtained evidence of the existence of an intrusive rock, viz. high up the Carrick Range, in small dyke-and-knoblike protrusions of a dark "hornstone-porphyry," and at Alexandra in several specimens of a similar porphyry, said to be derived from a reef-like outcrop (no doubt a dyke) on the N. slope of the Old Man Range. Captain Hutton, and Coleman of Alexandra, know of several more dykes of this kind in other localities. Massive occurrences of granite, such as characterize the neighbourhood of most of the Victorian gold-fields, are, however, quite absent.

As a general rule, both the phyllite and mica-schist, but more especially the latter, are rich in interlaminations of quartz, generally less than ¼ in. to near 1 in. thick, but sometimes assuming considerable dimensions—1 to 3 ft. in thickness—though with no regularity and permanency in strike and dip.

These generally lenticular-shaped masses, and, as a specimen shown Ulrich at Alexandra proved, also the small interlaminations of quartz, have at several places been found auriferous, which led to their being erroneously mistaken for true reefs or their leaders; and a considerable amount of money and labour has been wasted in their exploration. As a case in point he notices the workings on the so-called Butcher's Gully reef, near Alexandra. There, on a rocky, high table-land, consisting of nearly flat-bedded mica-schist, full of quartz interlaminations, a fine large shaft has been sunk 60 to 70 ft. deep, and furnished with a pump worked by a water-wheel, which received its water-supply by means of a long wooden flume from an extensive race on the neighbouring range. Gold at the rate of 6 dwt. per ton is said to have been crushed from the quartz; but as neither in the shaft nor in the stuff worked out of it, nor in the surrounding country, any indications of a reef are visible, the auriferous quartz found must, no doubt, have been derived from one or several of the small interlaminations, and the prospects of the place would, therefore, certainly not warrant further expense in more extensive exploration. There are certain inferences to which the existence of these auriferous quartz interlaminations leads, namely, that they may be more frequent and more widely distributed than hitherto supposed, and that the riches in gold of the drifts of the province are in some measure, at least, due to their denudation. As regards the strike and dip of the schists, they are subject to great changes throughout the country, the former running through nearly all directions of the compass, and the latter from horizontal to vertical, from one side to the other; and these variations are in some places, as for instance on the Carrick Range, so frequent, and exist in such close proximity to each other as to render the taking of any mean dip and strike quite a hopeless task. Therefore in the subsequent descriptions of the reefs, Ulrich has in most instances given merely the relative position of the latter to the country—i. e. whether they traverse the rocks either in strike or in dip, or in both. On the large scale, there exists, as already mentioned, according to Captain Hutton's observations, a main anticlinal axis running nearly N. and S., through the country, including the Carrick Range in its course, from which axis the average dip of the rocks is on the one hand E., on the other W.; and in the latter direction, more especially between Arrow and Skipper's Creek, a more than usual regularity obtains in the W. dip, as seen in the ranges bounding the Arrow and Shotover rivers.

The auriferous reefs opened throughout the province differ very much both in structure and mode of development. Still, there are some districts, of which, though they lie rather far apart, the reefs show much resemblance to each other in the above respects; whilst again in other districts, comparatively close together, the difference in the nature and behaviour of the reefs is very great indeed. Taking advantage of these alliances, in order to simplify the description, the reefs and other occurrences of gold in matrix may be grouped as follows:—

FIRST GROUP: The Saddle Hill reef, Green Island, near Dunedin; the reefs of Tokomairiro (Canada reef, &c.); the Gabriel's Gully reef, near Lawrence; the O P Q reef, Waipori.

SECOND GROUP: The reefs of Bendigo, near Cromwell; the Rough Ridge reefs; Conroy's Gully reef, near Alexandra.

THIRD GROUP: The reefs of the Carrick Range.

FOURTH GROUP: The reefs of Arrow and Skipper's Creek.

FIFTH GROUP: The reefs of Macrae's Flat and Shag Valley.

SIXTH GROUP: Exceptional occurrences of gold in matrix—the so-called Peninsula Quartz reef at Portobello.

1. Saddle Hill, Gabriel's Gully, O P Q, and Canada reefs are true lodes, promising permanency in depth. They have well-defined foot- and hanging-walls and clay casings or selvages, and cross the country (phyllite) both in strike and dip, though the difference in angle, either in strike or dip, or sometimes in both, is generally not considerable. In their [illegible]ure, development, and mode of occurrence, they resemble very [illegible] a certain class of Victorian reefs, called "block reefs," the typical characteristic of which is, that they are composed of generally a number of blocks of quartz, either with contractions of the lode-fissures between, or, which is the case here, alternating with blocks of "mullock"—the latter term meaning gangue matter, consisting of country-rock slipped into the lode-fissure, where, in course of time, it became more or less mineralized, impregnated with pyrites, and traversed by small quartz veins. These quartz and mullock blocks, which reach sometimes considerable dimensions, extend hardly ever vertically downwards, but show an endlong dip in strike within the fissures—N. or S., E. or W., as the case may be—in the same reef invariably, in the reefs of the same district generally, in the same direction. The feature may, in fact, be considered as an oblique banded structure on the large scale. In the reefs under notice, the thickness of the blocks reaches in some cases 12 ft., and their dip in strike is generally at rather flat angles. According to experience, gold occurs both in the quartz and mullock blocks; but the former have hitherto invariably been found the richest, and in them its distribution is mostly not uniform throughout, but, as found in the Gabriel's Gully, for instance, a rich small shoot dips at a flat angle across the block; or, as in the Canada, a number of narrow, richer runs, dipping in the line of the blocks,

are separated by poorer quartz; or, as in the Waipori, a certain thickness on the hanging- and foot-walls is richer than the centre, &c. The appearance of the quartz—and this appertains also to that of the reefs of the other groups—varies very much according to whether the stone comes from the surface or from beneath the water-level. In the first case, it is white, opaque, and mottled and striped with brown iron-ore, or ferruginous slaty matter; in the latter, it shows a bluish colour, is slightly translucent and glassy, and full of blackish spots and seams of slaty matter, which, as well as the quartz itself, are more or less densely impregnated with pyrites. With the exception of the O P Q, Waipori, which produced from the old workings a very good average per ton, and promises richer yields from the new ones, the other reefs of this group are rather poor in gold, the yields ranging not much above 5 dwt. per ton throughout. Still, considering the thickness and extent of the quartz blocks, the facility with which they can generally be worked, and that sometimes the intervening mullock is worth crushing, on account of thin rich quartz seams traversing it, they ought to be profitable to work—i. e. on a larger scale than has hitherto been the case—for at least several hundred feet in depth; more especially if attention is paid to the saving and treatment of the pyrites; and the truth of this opinion is in some measure already shown by the results of the Canada, which, though worked by shaft on a limited scale, produces from a depth of 80 ft., according to the manager's statement, a small profit from an average yield of 5 dwt. of gold per ton.

2. Ulrich's reasons for grouping the reefs of Bendigo, and the Rough Ridge, Conroy's Gully reef, near Alexandra, together, are based less upon their exhibiting unmistakable structural differences from the reefs of the other groups, than upon their similarity to each other in several respects, touching mode of development and relation to the country. Their thickness is, in the average, but small, ranging generally from ½ to 2 ft., and exceeding rarely 4 ft., and as far as workings have proved, they do not consist of solid quartz throughout, and but seldom so for any considerable extent in strike and dip (Logan's). They represent, in fact, in certain respects, "block reefs," though with this difference from the true reefs of this class, that blocks of quartz and mullock of irregular size and outline are more or less irregularly intermixed, and do not, as those of the latter do, dip at certain angles, and in the same direction in strike. Most of the reefs of Bendigo show well-defined walls with clay casings, strike nearly uniformly E. and W., are mostly traceable for long distances, and—what constitutes them very "strong" ones in a mining sense, and indicates permanency in depth—they traverse horizontal or very flat-bedded mica-schist vertically, or at very steep angles. The reefs of the Rough Ridge vary in strike, though not at large angles, and most are not

traceable far in strike. They are generally not so well defined as those of Bendigo, and seem liable to frequent irregularities in strike and dip, contractions, and more especially to being faulted by slides; but these unfavourable features are apparently the results of surface disturbance only, and may disappear in depth. It is not uncommon, both at Bendigo and Rough Ridge, that reefs split in strike into branches, which, though deviating at first from, assume gradually again the strike of the main reef, and run thus pretty close and parallel together, some increasing to the same or even a greater thickness than that shown by the latter.

Besides "leaders" that dip towards them, so-called "droppers," dipping at generally flat angles away from them, have also been observed in some of the reefs at both places. With regard to the mode of occurrence of the gold, the comparatively superficial work done on most of the reefs hardly permits to form a definite and generally applicable opinion. Judging, however, from those most extensively and deepest worked, it would seem that the metal is accumulated in rich shoots of variable width, that dip at rather steep angles in strike in the quartz blocks; whilst the portions intervening between the shoots, including the mullock patches, are poor, but generally rich enough, or of such limited extent as to render it the most economical to work them with the rest, without resorting to special selection. Excepting the yields from Logan's reef, as unusually rich ones, those from the other reefs have been by no means low in the average, as they ranged up to 2 oz. per ton, and from hardly a single reef were they reported much below ½ oz. per ton. Considering this, Ulrich was much astonished to see so many of the reefs and claims neglected (at the Rough Ridge, over 20 claims were once worked, whilst at present only a single one); but the reason was explained to him to consist partly in the high prices charged for crushing, partly in expensive cartage, and more especially in the want of enterprising miners, those who worked the top having become afraid of the hard work and expense required in contending with the water. With regard to the prospects of the reefs in depth, he considers them, where the reefs are well defined, as favourable, both as concerns persistency in auriferous character and regularity in average size. But in speculating upon profits to be derived from future working, several important points must not be left unconsidered—namely, the comparatively small size of the reefs, expenses connected with getting rid of the water, and greater difficulty in extracting the gold from the quartz; for below the water-level, which lies in several of the reefs considerably higher than one would suppose from their elevation above the nearest permanent surface water, the seamy quartz is throughout very metalliferous; in fact, it promises at greater depth to become more highly charged with metallic sulphides (arsenical and iron-pyrites, galena, zinc-blende, &c.) than in any of the reefs of the other districts examined. Timely attention to improvements in the gold-saving appliances is therefore highly advisable. The expense of working narrow reefs will, in depth, also considerably increase, in consequence of the increasing hardness and closeness of the country, which latter is comparatively more unfavourable to work on account of its horizontal bedding. However, against this may be placed, as a perhaps more than adequate set-off, the high dip of the reefs, which much facilitates working, and what is of greater importance, that the hardness of the rock in conjunction with its horizontal bedding renders the supporting of the workings very cheap and simple.

3. The generality of the reefs of the Carrick Range present in several respects quite distinctive characters from the reefs of the other groups. They are peculiar clayey ferruginous "mullock reefs" or rather "quartz-mullock reefs," so soft that they can mostly be worked by pick, without the aid of boring and blasting; and the quartz, which apparently forms no large percentage of their mass, occurs only in the shape of coarse sand and small angular and slightly rounded pieces—such reaching or surpassing the size of a fist being rather rare. Whether it represented originally interlaminations in the mullock, or was formed in veins, is uncertain, but a kind of banded structure in the line of dip of the reefs speaks in favour of the latter. These reefs vary in thickness from less than 1 ft. to over 6 ft.; they strike in all directions across the country, but are only of short extent, and differ very much both in direction and angle of underlie, the latter ranging from vertical to less than 20°. Some of the reefs show also much irregularity in their course, for they expand and contract, twist and curve in strike and dip in quite a peculiar manner, and are, what is the case also with most of the others, frequently faulted by slides and cross-courses, so that it requires very great attention and perseverance on the part of the mining managers not to lose them. Considering all these points in connection with the fact that the country —a rather soft phyllite—is also very much disturbed, both in strike and dip—steep and flat dips alternating and changing in direction within short distances—it appears next to certain that not only the peculiar soft and gravelly nature of the reefs, but also the exceptionally flat dips of some, are not original, but due to strong pressure, friction, upheaval, &c.; and as the cause of these disturbances, appears most likely the intrusion of the dark hornstone-porphyry, which, as mentioned at another place, occurs in small knobs and dykes at several places on the range (near Carricktown). Unfavourable as these features no doubt appear, touching straightforward and uninterrupted working of the reefs in future, Ulrich feels no apprehension of the latter giving out suddenly or at a limited depth, for they are in every respect true lodes, crossing the country both in strike and dip, and showing most frequently the hanging-wall, less frequent the foot-wall,

and in some instances both walls well defined and separated from their mass by clayey casings, mostly polished and striated, representing the so-called "slicken-sides," which afford unmistakable proof of movements of the walls of the reefs.

The gold, both in the quartz and mullock, is very fine, and owing to the soft and ferruginous nature of the stuff, specks can but very rarely be seen during working. Judging from the crushings and occasional washing of prospects, it occurs chiefly in shoots dipping in strike, less in irregular patches, but seen also to be pretty generally distributed throughout the whole extent of the reefs, as far as opened. The yields of most of the reefs opened have in the average been very fair, as they ranged between ½ and 1½ oz. per ton. On account of its softness, the quartz mullock is easily crushed, but the saving of the fine gold requires great attention; and as the supply of water, which the proper treatment of this kind of stuff requires, is rather above the average, but has at the existing machines been frequently much below it, and their saving appliances are not the most suitable ones besides, Ulrich is sure a great deal of the gold has been lost in the tailings. There is at the level of even the lowest workings not much pyrites observable in the reefs: still the ferruginous character of the mullock, as being no doubt a result of its decomposition, points to its former presence in larger quantities, and it may with certainty be expected to increase in abundance in depth. As regards the expense of working the reef, the soft nature of both the mullock and country renders it small in one respect, viz. that of exploitation proper; in another, however, viz. that of supporting the workings, rather large, on account of the high price of timber, and the expense in this respect increases of course, in order to avoid accidents and collapse, the flatter the dip of the reefs. Fortunately there are on this field experienced managers and miners, well able to cope with this difficulty in the most economic and practical manner.

4. The only reefs of the Arrow and Skipper's Creek group in course of being worked, and of which Ulrich was able to examine the workings, were Southberg's and the Nugget and Cornish, Skipper's Creek; still, from examination of the outcrops of some reefs at Arrow, and information received about the character of a number of others once worked, but since abandoned, in both districts, he was enabled to form the following opinion on the general character of the group. These reefs are true massive lodes, ranging from 4 to over 20 ft. in thickness, which cut through the country both in strike and dip—the latter being generally steep—and show more or less well-defined walls, with clay casings; a number are traceable for long distances—some for miles—in strike. In point of composition and structure, they approach, however, far more mullock reefs than true quartz reefs—they represent, in fact, fissures

partly filled with débris from the "country," full of interlaminated quartz, partly occupied by bunches and veins, of variable size, of true reef-quartz. The mullock seems in the larger reefs to be generally predominating, and forms, in places where their width very much increases, by far the greater part of their mass. In fact, experience tends to prove that the thicker a reef is, or the wider it becomes, the more mullock it contains, whilst, on the contrary, decreasing thickness is connected with a relative increase in quartz, and the reefs become also better defined. The bunches and veins of reef-quartz occur either on the hanging- or foot-walls, or on both walls, rarely in the centre. They appear to dip shoot-like in strike, and are generally payably or richly auriferous; but the somewhat mineralized mullock, with its interlaminations and fine cross-veins of quartz, has also, in all the reefs opened, been found to contain gold throughout, though generally only in payable quantity within the line of the quartz shoots, or where the reefs much contract in size. The yields have ranged from several dwt. to over 4 oz. of gold per ton, but the average from the reefs at present worked is 10 to 16 dwt. per ton. Although none of the reefs at Skipper's Creek has as yet been opened below permanent water-level, they are already highly charged—both quartz and mullock—with pyrites, which seriously interferes with the satisfactory saving of the generally fine gold during crushing. This led the Phœnix Co., after F. Evans, the manager, had proved the payably auriferous character of the ore as such, to erect in connection with their crushing mill the necessary works for extracting the gold from the large quantity of it saved on long blanket-strakes. The country is, with regard to most reefs, very favourable for their being easily and cheaply worked, owing to the highly precipitous nature of the mountains which they traverse, and the deep valleys and gorges from which they can be opened, either directly in strike, or by but short cross adits. Still there is at Skipper's Creek one serious drawback to regular and systematic working, affecting the most important of the reefs within certain depths, namely, although the country-rock (mica-schist) appears on the large scale but little disturbed in strike and dip, it is throughout highly fissile, and traversed by numerous cracks and joints; and these features combined, aided by percolation and freezing of water, have originated enormous slips from the precipitous mountain sides—faults, in a certain sense—by which the continuity of the reefs is completely broken. In fact, nowhere on the slopes of those steep mountains can the miner be certain of having a reef exactly in its original place or unshifted. These disturbances, which render working dangerous and cause much expense in timbering, extend, however, to within the level of the nearest gorges or valleys only; below this there is every probability of the lie of the reefs becoming less broken, though the existence of smaller faults and other irregularities must there also be apprehended on account of the fissured nature of the country. As regards the continuance of the gold in depth, Ulrich sees no reason to doubt it, yet thinks it very likely that the doubtless increasing abundance of pyrites may, as in Victoria—and this refers also to the reefs of all the other groups—be connected with a corresponding decrease of fine, free gold, in depth.

5. In point of definition and mode of occurrence, the reefs of Macrae's Flat and Shag Valley, which he found all deserted, are, in Ulrich's opinion, the least promising ones of the province. Judging from those he could examine, and information obtained about a few others that have been prospected, they represent either so-called "layer-lodes" (Duke of Edinburgh reef, Macrae's Flat, Shag Valley Freehold Co. reef), or are merely interlaminations between the beds of phyllite that form the country in both districts.

Touching the layer-lodes, their general characteristics are, that they strike and dip with the country, having the foot-wall (one and the same country) generally pretty smooth throughout; but the hanging-wall mostly quite irregular, uneven, and traversed by leaders. They are, on account of this mode of relation to the country, subject to all the changes in strike and dip of the latter, and, if these are great, are liable to frequent alterations in thickness, and can generally not be depended on for persistency in depth. In the cases under notice, the stratification of the country is fortunately pretty regular, and all points are therefore in favour of the reefs being also more regular in course and thickness, and having a better chance of persistency in depth, than is usually the case. Their dip is rather flat (less than 45°), and they are 2 to 5 ft. thick in the average, being composed of mullock and rather good-looking quartz; the latter generally predominating and occurring in bunches and veins, mostly on the foot-wall, sometimes on the hanging-wall, or being irregularly intermixed with the mullock. The gold occurs both in the quartz and the mullock, though mainly in the former, and the yields have ranged from a few dwt. up to 2 oz. per ton, but did not pay in the average; therefore the reefs were abandoned at a very shallow depth. Considering that the gold did not run out, and that the reefs, as far as opened, show a good thickness for considerable extent, in connection with the circumstances under which they were worked, the advisability of giving them another more extensive and systematic trial certainly deserves consideration. With regard to the interlaminations, which were considered to be reefs, and of which some are in places several ft. thick, they conform in all respects to what was said about these bodies in the beginning. That they are quite unreliable, concerning gold-bearing character and extent in strike and dip, is proved by the fact that, though several carried good gold (above 1 oz. per ton) near the surface, either their irregularity or impoverishment, or both cases combined, rendered working soon unpayable, and they were deserted in consequence, and do not invite renewed and more extensive prospecting.

6. The exceptional occurrences of gold in matrix, the so-called Peninsula quartz reef at Portobello, which Ulrich inspected, in company with Captain Hutton, the Provincial Geologist, do not, though believed to do so, represent a quartz reef at all, but are, as far as the superficial workings and the reported results of trials allow one to judge, impregnations of gold in a finely divided state through various kinds of rock that will be described farther on. In a geological point of view, the auriferous locality and neighbourhood are most interesting, and would well deserve a special detailed topographical and geological survey. True trachyte, trachyte-breccia, and tufa, and indurated ash-beds, broken through by dykes, and irregular dyke-like masses of basalt, compose principally, as it seems, that part of the Peninsula, whilst sedimentary rocks—sandstone and limestone—the geological relation of which requires yet to be determined, form apparently a narrow strip between it and the mountain on which Larnach's mansion is built. This mountain, consisting in its upper part of trachyte and basalt intermixed, seems from half-way down its slope, towards the base, to be composed of sandstone, which in a small quarry is clearly seen to dip underneath the volcanic top rock. As regards the places opened—4 in number, in 3 of which gold has been proved by trial crushings to exist,—they lie pretty nearly in a line (the supposed line of reef) down the steep slope of a mountain, at that part composed of greyish-white trachyte. Progressing from above downward, the place highest up the slope consists of an old saw-pit, from which a short prospecting drive has been put into the mountain. Quartz of a rather concretionary character was here found in the shape of an irregular bunch, enclosed within trachyte—the whole quantity lying around amounting to about 1 ton. In this, no gold was seen, and no trial was made of it; but a specimen has been reserved for assay. The second opening, about 100 ft. lower down hill, is a small shallow excavation in trachyte, which is here full of siliceous segregations of irregular outline—some nearly 1 ft. in diameter—of a quartzite-like character and bluish-white colour ("bastard quartz," in miners' phrase), in which very fine grains of pyrites can be seen in abundance. Of this stuff, of two trial crushings, one of 2 cwt. gave 18 gr., the second of a ton yielded ½ oz., of gold; and Forbes and McAuley, the prospectors, affirmed that they could wash a pretty fair prospect of fine gold from every tin dishful of the small stuff excavated. In the third opening—a small open cutting, some 60 ft. below the previous one—very close-grained white trachyte was excavated, of which a trial crushing of a ton yielded 3 dwt. of gold.

The fourth and last opening lies at the foot of the mountain, and consists of a good shaft of 40 ft. in depth, with a small drive at the bottom. It penetrated for the first 25 ft. through loose ground, and the last 15 ft. through a decomposed cap into a hard coarsely crystalline rock, composed of hornblende, triclinic felspar, and some quartz, and being more or less densely impregnated with very fine grains of pyrites. This rock continued also in the drive. Three trials were made, viz. two of the hard rock of 1 ton and ½ ton, which yielded respectively 8 dwt. and 11 dwt. of gold; and the third of 1 ton of the softer decomposed cap rock, which gave, strangely enough, only 6 dwt. of gold, whilst generally, decomposed portions of pyrites-bearing rock are richer than undecomposed ones. All the recorded trial crushings were executed at a good battery in Victoria, and, in order to remove further doubt about the genuineness of this strange auriferous character of the quartzose white trachyte, and the rock from the shaft, several small parcels were most carefully tried in Dunedin, and these all produced gold. Accepting the auriferous character of the rocks, therefore, as satisfactorily proved, and considering that between the places opened there exists virtually not a feature such as would indicate a narrow auriferous zone or streak in their line down the mountain side, whilst it would seem very improbable that just by accident the auriferous portions of the rocks were opened and exhausted, we must come to the conclusion that there is a great likelihood of the gold being generally disseminated—richer and poorer in places—through these peculiar varieties of rock as far as they extend. As the matter stands, the average results of the washings from Nos. 2 and 4 workings are certainly such that, taking into account the facilities the ground offers for mining, abundance of timber close by, &c., they should render working on a large scale, with ample crushing machinery near at hand, highly payable. Considering this, it would be really deplorable if the still lingering doubts of the reliability of the results of the trials made, i. e. whether the gold really came out of the stuff and not out of the crushing-machine, were not definitely set at rest by a further and more extensive trial, say of 10 to 15 tons from each of the two good places.

Strange as the occurrence of gold in such matrix, and under such circumstances, no doubt appears, it is in reality not without its alliances—at least, in certain respects--both in another part of New Zealand and in foreign countries. Captain Hutton, who is intimately acquainted with the Thames gold-field, North Island, recognized at once a certain resemblance between the geological features of the locality under notice and those of the Thames district. He thought the greyish-white trachyte of the former looked much like the gold-bearing trachyte-tufa of the Thames, though there, as well known, the gold is found in bunches and veins of genuine quartz, and does not occur finely disseminated through the mass of the rock. The hard crystalline rock of No. 4 workings, he also considered similar to a rock, of which dykes traverse the original tufa of the Thames, but which itself had not been found auriferous. As regards Ulrich's own experience touching this rock, he thinks the latter bears considerable resemblance to certain trachytic rocks (trachyte-greenstone) which he saw on a journey through Hungary and from Transylvania, and which are there rich in auriferous silver and lead lodes. But from comparative examinations of specimens, he can also state that in mineral composition it is quite identical with, and in appearance hardly distinguishable from, the quartzose diorite-greenstone of some of the dykes which in Victoria traverse Upper Silurian rocks, and are themselves traversed by generally highly auriferous quartz veins. That the rock is, notwithstanding this latter close resemblance, of volcanic origin, and represents in reality "trachyte-greenstone," there can hardly be a doubt, however, on account of its mode of association with the typical trachyte of the locality. For besides in the shaft, close round which the greyish-white trachyte is plainly exposed, outcrops of it (the greenstone) have also been found in several places in a neighbouring gully which cuts through trachyte, and on the slope of the trachyte range. According well with this opinion about its origin, and what it lithologically represents, and further showing the importance of this kind of rock, is what the celebrated geologist Von Richthofen reports from the Washoe county and other parts of America, namely, that the rock there most prolific in gold and silver lodes is a volcanic rock of the trachyte series, closely allied to diorite both in composition and appearance, and for which he proposes the name "hornblende-propylite." Considering all the foregoing observations in connection, there exists, besides what we already know of their auriferous character as such, the chance that any quartz reefs or veins found traversing the trachyte and trachyte-greenstone in the locality under notice, or in fact wherever they occur, may prove highly auriferous. And on this account, not only the neighbourhood of the workings, but the whole of that part of the Peninsula, is well worth a thorough prospecting, the shore line, showing the rocks generally plainly exposed, offering in this respect special advantages.

Prospecting for new Auriferous Reefs.—As regards the chances of the occurrence of other auriferous reefs in the districts under notice, Ulrich considers them to be very good. In the neighbourhood of Saddle Hill reef, 4 good-looking, strong reefs crop out, which, as superficial prospecting has already proved them to be slightly auriferous, might likely yield payable stone on being tried at other points in their lines of strike. But, besides this, there is, in his opinion, a very good chance of the existence of an auriferous reef about the head of a highly auriferous gully, worked abreast of the Saddle Hill reef, on the right side of the main road leading from Dunedin to the Taieri. In the neighbourhood of the Canada reef, Tokomairiro, the finding of rich quartz specimens outside the lines of the reefs opened, coupled with that of rich, nuggety gold in the N. branch of the Tokomairiro river, is pretty good evidence of the occurrence of other auriferous reefs in that district. That the Gabriel's Gully reef should be the only auriferous one in the Tuapeka district is also very unlikely. And, touching the country round Waipori, where no systematic prospecting seems to have been carried on at all, he feels quite convinced that good reefs exist besides the one in work—not only in the neighbourhood of the latter, but also in the ranges on the opposite side of and about the head of the Waipori river,—in order to account for the gold in the drift of the Waipori Valley, the angular specimens of auriferous quartz, and the patches of highly auriferous angular drift found here and there in the ranges. At Bendigo, the Carrick Range, and Skipper's Creek, where the tracing of auriferous gullies and quartz specimens led, he was told, to the discovery of most of the principal reefs worked, though some showed by no means plain outcrops at the surface, partly by reason of their mullocky character, partly on account of being covered by detritus or being disturbed. And these features are the most serious obstacles the intelligent prospector has to contend with in these districts, for that the latter are promising fields for further discoveries of quartz reefs is plainly indicated by numerous auriferous alluvial gullies and creeks, and the occurrence of quartz specimens outside the drainage range of the known lines of reefs. The recent discovery, by tracing specimens, of a new reef in the Bendigo district, presents a case in point. The same reasoning, based upon similar data, applies more or less to all the other reefing districts (Arrow, Rough Ridge, &c.). And not to them alone, but also to the N. and S. slopes of the Old Man Range, and to the rich alluvial diggings dotted along the edges of the Manuherikia, Idaburn, Upper Taieri, and other main valleys, though the reefs that, in the latter cases, supplied the gold to the drift would most likely lie in the ranges at the heads of and bounding the permanent creeks and rivers, entering the main valleys at, or in the neighbourhood of, the diggings. With regard to accepting the occurrence of massive auriferous drift or of mere surface at any place in rangy country as a promising indication of the existence of auriferous quartz reefs in the neighbourhood, the prospector ought to pay special attention, however, to one point, viz. to the nature of both the drift and the gold, i. e. whether the pebbles and gold-specks are water-worn or not. For, if the first is the case, the deposit may be a remnant of a former terrace formation far transported from its original source, whilst the more angular the stones, the more hackly and crystalline the gold-specks are, the nearer lies their place of derivation. There is one district hitherto only known as an alluvial diggings, which, according to information afforded to Ulrich by L. H. Preston, Jenkins, McDougall, and Smith, of Arrow, presents first-class indications of being a good reefing district. This refers to the Twelve-mile Creek diggings, and mainly to the Great Barrier Range, in which the Arrow and Twelve-mile Creek take their rise, and that forms the watershed between them and the Shotover river, the position of the tract being pretty nearly in the line of strike of the Skipper's Creek reefs. A big reef runs right along the top of the range, and in the drift of the top part of the Twelve-mile Creek, Scanlan's Gully, Specimen Point, and in that of Rodger's Gully and Tobin's Point, at the head of the Arrow river, rich quartz specimens were frequently found, and shown at the stores and banks of Arrowtown; whilst, at certain points in the Twelve-mile Creek, large quartz specimens can be seen—one of nearly ½ ton in weight—showing fine specks of gold all over. The gold obtained from Rodger's Gully was generally so quartzose that it required careful crushing and separation of the quartz before it could be sold. Lower down country, about ½ mile from the junction of the Twelve-mile Creek and Arrow river, a mullock reef, full of quartz veins, appearing as a wall-like formation on the mountain side, was cut through by a race, in which it proved to be 8 ft. thick, showing well-defined walls, and dipping nearly vertical. Its promising appearance led a party of miners, some time ago, to prospect it; but, though gold was found in the stuff, they deserted the reef again, and no work has been done on it since. Strong evidences of auriferous reefs are said to abound in many other places on the Arrow river, and over the Twelve-mile Hill, and only await the pick of the enterprising prospector for their development.

Concluding with a general comparison between this province and Victoria as to the facilities and chances of prospecting, Ulrich says that this work—looking at it in a strictly mining point of view only—is here much more difficult than in Victoria; for, whilst there, reefs consist mostly of massive white quartz, and are plainly exposed on the surface, they are here more frequently of a mullocky character, and more or less covered over by detrital matter. And there is besides one striking difference between the two countries, namely, that whilst in Victoria reefs abound all through the gold-fields, but, as the saying goes, 99 per cent. prove barren, here they are comparatively very scarce, but with this redeeming feature, that nearly every one hitherto found has proved to be auriferous, and therefore we may fairly assign the same chance to any new ones discovered in future.

Machinery and Appliances.—The number of crushing-machines erected and in course of erection at the different gold-fields Ulrich visited, amounts to 21, 18 of which—including 2 near completion—are for quartz crushing, whilst the remaining 3—including 2 in course of erection—are for crushing the cement of the Blue Spur.

Speaking of the crushing machinery proper, all these machines are, with but slight variations, constructed after the same model, viz. they consist of batteries of revolving stamps, 4 and 5 in a battery, worked in cast-iron coffers on false bottoms, and being partly fed by hand, and partly supplied with self-feeding hoppers. As far as Ulrich could see, they are all well and substantially erected, the comparative freedom from jar of those found at work proving their stability, and that due care had been bestowed upon the preparation of their foundations. At one or two machines, the discs on the shanks were not quite in order, and the wipers were too long; but the managers knew of these defects, and were going to repair them. On the, at one time in Victoria, much-discussed question, whether round stamps are equal in crushing power to square ones, Ulrich remarks that careful experiments under equal conditions have proved that they are nearly, if not quite, as effective as the latter, whilst their wear and tear, in consequence of the turning, is in the average less. In the weight and lift of the stamps, and the speed at which they were driven, there were considerable differences between the machines, the weight ranging from 4 to 7 cwt., the lift from 5 to 8 in., and the speed from 56 to 85 blows per minute. As regards the most advantageous weight for stamps, opinions are still divided in Victoria; still, heavy stamps are, on account of greater efficiency on the generally hard quartz, the most in use. In Ulrich's opinion, a medium of about 5½ to 6 cwt. would best suit the character of the stuff of most of the Otago reefs, though for such as consist principally of hard, more or less solid quartz—as, for instance, Logan's reef, the Canada reef, &c.—stamps up to 8 cwt. would, no doubt, be preferable.

Touching the height of drop and speed of the stamps, the former should not be less than 7 in., and might advantageously be increased to 9 in., especially if the stamps are light; whilst touching the speed, it is generally considered best at the rate of 75 to 80 blows per minute. On the amount of stuff crushed during a certain time he could not obtain any definite information; but the figures given seemed to him rather low, and in order, therefore, to show what ought to be done under certain conditions, he mentions that at the Port Phillip Co., Clunes, stamps of 6 cwt., driven at a speed of 75 blows per minute, and with a drop of 8 to 9 in., crush in the average 2 tons 4 cwt. per 24 hours; whilst others of 8 cwt., with the same fall and speed just given, are expected to reduce each up to 5 tons per diem. Regarding the iron coffers, they seemed to him rather, if not too shallow for both economic and effective working.

They allowed hardly 1 in. of loose quartz to be put beneath the false bed-plates, and it would, therefore, require the greatest care in the placing of these plates, the feeding, &c., to prevent the plates from working unevenly into the shallow gravel bed. In fact, he thinks it can hardly be avoided that they (the plates) come frequently into contact with the iron bottom, the result of which, of course, is, as the sound of the blows already indicates, ineffective working and great wear and tear—sometimes even an unexpected breaking of the coffers. On this account, he thinks it would certainly be advisable to have the latter about 2 in. deeper, so as to allow a gravel bed of 3 in. beneath the false bottoms. Considering that the office of these latter is not only the saving of the coffers from wear and tear, but mainly to prevent the gold from being smashed too fine, or "beaten dead," as it is called, they should be only of the same size as the stamp-heads, in order to leave sufficient space around them for the liberated gold-particles to get into the gravel out of reach of the stampers.

The provision of self-feeding hoppers—a great desideratum for saving labour—has been neglected at a great number of the machines, and would deserve early attention. Many practical quartz-crushers consider, and no doubt rightly, that hand-feeding, if properly executed, is more effective; still it is extremely doubtful whether, especially in the case of small machines, the value of the increase in the quantity of stuff crushed is equal to that of a man's labour; in Ulrich's opinion, this labour is far more profitably applied to attending upon the gold-saving appliances. With only one or two exceptions, he found the great defect of the coffers having only front discharge; for it must stand to reason that, as it is, or ought to be, the aim to get the finely crushed material quickly out of the boxes, large escapes both in front and at the back are the most effective. Of course, such a double-discharge arrangement necessitates a corresponding increase in the quantity of water to be supplied per stamp-head: a supply of 5 to 8 gal. per head per minute, regulated according to the weight of the heads and the nature of the crushing-stuff, would, however, satisfy all requirements. The gauge of the gratings, varying at the different machines from 122 to 144 holes per sq. in., is, he thinks, scarcely well adapted to the nature of the stuff treated; for as the gold is mostly very fine, the gratings should be very fine also, in order to ensure the necessary degree of reduction for a satisfactory liberation of the gold-particles. Gratings with 169 to 196 holes per sq. in. would certainly be safer.

As regards the gold-saving appliances in use, they consist, with the exception of two machines, which have deep drop-ripples attached, of amalgamated copper-plate tables, in some instances with improvements in the arrangement of the ripples, and all, except the cement-crushing machines, have various lengths of blanket-strakes succeeding. During working, it is the regular custom to put mercury into the stamper-boxes. For the treatment of the blanket-sand, serve the common revolving barrel with shaking-table or tyes attached, dolly tubs, small Berdan machines and simple tyes, though the latter inferior appliances at a few machines only. Although generally well constructed and carefully attended to, as Ulrich found these appliances at the machines at work, and as they respectively are, and were said to be at those at a standstill, most of the managers he came into contact with were well aware that they lost a considerable percentage of the gold, and in some instances notable quantities of mercury besides. Considering this general loss, which in some establishments was occasionally much increased through an insufficient supply of, and the use of muddy water, he attributes it mainly to 3 causes, viz. the use of amalgamated copper-plates, too strong an inclination and insufficient length of the blanket-strakes, and last, though not least, to the introduction of mercury into the stamper-boxes. It would lead too far here to enter into a discussion upon the merits or otherwise of copper-plate tables generally; suffice it to say that tables of the same pattern as those under notice were, at one time, in high favour in Victoria, but careful trials soon proved their inefficiency in many respects, and they have at all the principal crushing establishments been long ago discarded in favour of more perfect appliances, to be mentioned farther on. According to Küstel and other authorities on the subject, they have also suffered a similar fate long since in California—the country where they were first introduced. The putting of mercury into the boxes is no doubt a great improvement in case of copper plates being used, but it is fundamentally detrimental in the crushing of stuff so highly charged with pyrites as most of the Otago reefs produce. For it is a well-known fact that pyrites generally, though certain kinds more than others (and these abound in the latter reefs), cause a flouring of the mercury and amalgam in the boxes, and for the saving of such floured stuff no method has yet been discovered. On this account, he strongly advises to abandon the practice, even in case of copper plates being retained; for the loss both in mercury and gold caused by it alone is, perhaps, much larger than what would be sustained by less efficient working of the plates through its disuse. He takes the opportunity to remark, that he holds the practice of special harm with regard to the cement-crushing machines at Blue Spur, on account of the abundant occurrence in the bottom portions of that cement of secondary pyrites, i. e. such formed in the drift, a kind that through easy decomposition is very prone strongly to flour the mercury. Considering also that the generality of the gold crushed from the cement is dirty, i. e. more or less coated with oxide of iron, or pyrites, and that therefore the copper-plate tables (which he found only in use) have but a poor chance of retaining it, he thinks the attachment of blanket-strakes, or perhaps better of a well-constructed tail-race, would be found very profitable. Touching the blanket-strakes, they are, at most machines, 10 to 14 ft. in length, and their inclination is seldom less than 1½ in., and reaches 2 in. per ft.: both figures which, considering that the supply of water is mostly rather copious, are certainly not calculated to ensure a satisfactory saving of the fine gold and amalgam escaping from the copper plates; irrespective of that, at some machines, the blankets are not, or have not been, washed frequently enough.

Having given his opinion on the point from whence at least the greater percentage of the loss in gold and mercury proceeds, he recommends the exchange of the present appliances and system for, or respectively their modification according to, those for years successfully in use at the Port Phillip Co.'s works, Clunes—an establishment which in Victoria occupies the foremost place in satisfactory gold-extraction, mainly because the practice there introduced of daily taking and assaying samples of the tailings serves not only for controlling and guiding the working of the appliances adopted, but in the case of any new invention in gold-saving being tried, it affords also the best proof of the merits or otherwise of the latter. The system of appliances used at Clunes simply consists — starting from the battery—of 3 connected mercury-troughs—the first with a 10-in. drop, the second with a 9-in., and the third, or lowest, with an 8-in. drop—through which the material passes in succession, to run next over 24 to 27 ft. of blanket-strakes, laid at a pitch of only 1 ft. in 16, and ultimately to pass from the blankets through another mercury-trough before it reaches the waste-channel. This last trough is only cleared, however, at intervals of several months, whilst the upper troughs are cleared every week. In order to keep any coarse stuff from entering these latter, and also for even distribution of the material, a perforated plate is fixed right in front of the battery, through which both back and front discharge pass on to an apron which leads it (the material) into the first trough. An important part of each trough is the splash-board, which, reaching down to within about one and a half inch of the bottom (of the trough), near to the surface of the mercury, compels the material, in its drop, to pass more or less through the latter before rising over the lip of the trough. All the troughs are supplied with tap-holes on one side, by means of which the mercury and amalgam can be drawn off when required. The whole system will be minutely described and illustrated in Chapter VI. As to the blanket-strakes, their small inclination requires the supply of water to be up to 8 gal. per stamp-head per minute, according to the nature of the stuff, in order to keep them free from sandy settlement. The rate at which the blankets are washed at Clunes is generally the upper row every hour, the second row every 2 hours; and of the remaining length of the strakes the blankets of the upper half every 6, those of the lower half every 12 hours. Considering the nature of the stuff of the Otago reefs, Ulrich thinks, however, that, partly because the more or less slimy stuff from the mullock reefs renders the surface of the blankets quickly inactive, partly on account of the great amount of pyrites contained in the quartz, a more frequent changing of the blankets than the above is advisable.

Touching the treatment of the blanket-sand, the method in use at most of the machines, viz. by revolving barrel and shaking-table, gives, if properly carried out, the most satisfactory results, and deserves, therefore, general adoption. In the proper working of the barrel, upon which depends most, certain rules require to be followed, however, and as he had no opportunity of judging of the mode of operation at any of the machines, he gives the following particulars on this head for comparison and guidance. Assuming the barrel to be about 4 ft. long by 2 ft. in diameter, it should be charged with 8 to 10 cwt. of damp sand, and 200 to 300 lb. of mercury, and set to revolve for about 8 hours at a speed of 14 to 16 rev. per minute. After this, it should be filled with hot water and set to revolve again for another 4 hours at the rate of 5 or 6 rev. per minute, when the operation is finished, and the charge—mercury first—may be drawn off. Having been informed that at several of the machines the practice is followed of putting round stones or pieces of iron into the barrel, in order to grind the sand finer and aid the amalgamation of the gold, Ulrich remarks that he considers this proceeding likely to prove more harmful than advantageous, on account of the large quantity of pyrites generally present in the sand, which through the grinding is very likely to sicken or flour the mercury and amalgam, and this invariably is followed by a loss of mercury and gold afterwards. A determination of the exact loss of mercury in this and the main gold-saving process by carefully weighing the metal at short intervals, is not practised, as far as he could glean, at any of the machines; but as it is of the greatest importance in testing the comparative efficiency of the amalgamating appliances, it ought certainly not to be neglected in future.

Having noticed all the principal points touching the saving of gold from the crushed material, it remains to draw attention to the saving and treatment of the pyrites, which, as already mentioned, occurs in greater or less abundance in most of the quartz reefs of the province. Although small experiments have as yet been made of the pyrites of but a few of the reefs, and trials on the large scale of that of only one reef (Southberg's, Skipper's Creek) proving the payably auriferous character of the ore, still he thinks there can hardly be a doubt, judging from Victorian experience, that the pyrites of all the other auriferous reefs of the province is more or less payably auriferous also; and it would be highly advisable, therefore, after the truth of this supposition has been established by fire assays, to take early steps towards the concentration of and the extraction of the gold from the ore. Both these operations are not, however, very easy ones; but require for profitable and satisfactory execution, much care, favourable natural conditions, and a considerable amount of capital in the construction of the necessary works. The saving operation has to be effected at each single crushing-mill, and for it the so-called Borlase's buddle, with Munday's patent scrapers, is the most approved in Victoria; but where capital and favourable conditions are wanting for the erection of these rather cumbrous machines, the use of a good length of blanket-strakes—say 20 to 30 ft.—and careful attention to and more frequent washing of the blankets than hitherto practised, would at least save the greater quantity of the pyrites. With regard to the after treatment of the latter for the extraction of the gold, roasting-furnaces and certain kinds of amalgamators are required, the working of which has to be specially learned. In fact, it may be said to constitute a special industry, which not every company or reef-owner might care or be able to enter into. In Victoria, nearly all the larger companies have their own pyrites-works; but there are also special private establishments of the kind, unconnected with crushing-mills, at which miners or companies can either have their pyrites treated at a fixed rate per ton, or can sell it at a certain reduction on its gold value, which latter is ascertained by careful metallurgical sample assay. A similar course must be left for private enterprise to follow in Otago.

In view of the fact that in the reefs of Victoria—and this, as already stated, will most likely also happen in the reefs of Otago—the pyrites generally increases in quantity in depth, whilst the free gold correspondingly decreases, and that, moreover, the latter is the more difficult to save the more pyrites the stuff contains, the pyrites question, as it is called—referring to the best modes of concentration and after treatment of the ore, sanitary precautions connected with the roasting, &c.—has there for years been one of increasing importance, and the Government appointed some time ago a Commission to fully investigate the subject in all its bearings. The recently published report of this Commission contains full information, with drawings of machinery, &c., on the best methods of pyrites concentration, and gold extraction. Considering, in conclusion, the general working effect of the crushing-machines throughout the gold-fields of the province, there are two serious natural disadvantages under which all suffer, though some in a stronger degree than others. He refers to the hard frost in winter, and the general low temperature of the water throughout the greater part of the year. The former compels the actual stoppage of the works for several months

(5 or 6 months at Skipper's Creek); the latter affects the liveliness of the mercury, and thereby impairs, as it were, its amalgamating power. Against the first nothing can be done, and to ameliorate the second difficulty the introduction of hot water into the coffers can only conveniently be practised at those machines driven by steam-engines. However, he thinks that, whilst the introduction of long blanket-strakes would prove a great safeguard against any loss of gold caused by imperfect amalgamation, the most rational way to meet the frost difficulty would be to have all parts of the machinery sound and in best working order, so as to guard against interruptions in crushing day and night through the summer months, in order to work up as well the crushing-material accumulated during winter stoppage, as also that concurrently produced.

Auriferous Drifts.—On this head, Ulrich records some observations that his time allowed him to make, whilst travelling between the different quartz-mining centres. Not having seen enough, therefore, to attempt any geological classification of the drifts, he simply separates them into "newer" and "older," "upper" and "lower" drifts, as the case may be —main divisions, the existence of which every one interested in the matter will easily recognize on visiting the gold-fields.

Under the head of newer drift, belong all those extensive striking terrace formations of shingle and sand, and a certain thickness, running from a few to perhaps over 100 ft., of the flat stratum of similar material on which they rest, accumulated in far-stretching, wide portions of the present river-valleys, the original character of which as lake-basins has long been recognized. The terrace formations of shingle, &c., resting on the rock of the ranges, fringing the valleys, the drift occurring in the smaller valleys or gullies between the ranges and the real drift, are also here included. Besides the extensive sluicing operations which he saw executed in this drift along the banks of the Molyneux, Kawarau, and Shotover rivers, the really grand scale on which hydraulic sluicing is carried on at Tinker's (Blue Duck Claim—manager M. J. Spratt) and Drybread diggings excited most of his admiration. To give an idea of the scale, he mentions that, at Drybread, Greenbank & Co. use 40 sluice-heads of water with a mean vertical pressure of 130 ft., lessened about 25 ft. through friction in the pipes, and have 4500 ft. of iron piping, besides an expensive stock of necessary appurtenances on the ground. Although the stuff washed is very poor, still the enormous quantity sluiced through in a short time, work being carried on day and night, renders the operation highly profitable. Work like this is entirely unknown in Victoria; perhaps the only other place in the world where it is practised being California. The thickness of the drift which rests on the so-called "Maori bottom" surpassed, in some places, 30 ft., and considering this in connection with the promiscuous way in which patches of it are worked along the foot of the Dunston range, though the generality are in front of, or near, the mouths of large permanent creek-valleys, one cannot help coming to the conclusion that the gold extends all along the foot of that range, the richer accumulations existing most probably in front of where the latter is most broken by rifts and gullies, whilst towards the centre of the wide valleys it no doubt decreases in quantity, owing to causes to be explained farther on. And the same chance, he believes, exists not only along the foot of the range on the opposite side of the wide valley, but also round the edges of all the other large old lake-basins. In fact, the resources of the province in this kind of auriferous drift alone are practically inexhaustible, and their successful development only requires more of the enterprise and energy, as displayed by Greenbank & Co., in rendering the splendid water resources of the province available for hydraulic sluicing. As some of the places which he considers very promising, and certainly deserving of the special attention of the drift miner, he mentions the part of the old Clutha lake-basin in the angle where the Bendigo Creek enters, and along the foot of the range on which the Bendigo reefs occur. Also the extensive so-called Miller's Flat, between Arrow and Queenstown, which, to all appearances, represents an old channel of the Shotover river, and should, as such, be very rich, judging from the splendid yields obtained from the river workings higher up. Warden Beetham first drew his attention to this dormant field, the high prospective mining value of which is believed in by many miners in the district. Another very promising area he takes to be the extension of Macrae's Flat towards the Taieri river.

The older drift comprises all those enormous deposits of harder gravel and cement called "false bottom," "Maori bottom"—from its brown colour,—upon which the newer drift rests in the extensive old lake-basins of the Manuherikia, Upper Taieri, Clutha, and other river-valleys. Also, the cement and gravel worked on the tops of the ranges between Milton and Havelock, that remarkable cement deposit of the Blue Spur near Lawrence, and the false bottom of Weatherstone and Waitahuna Flats, which three latter, it must be borne in mind, represent also nothing else than lacustrine deposits, though small in surface extent, yet of comparatively great depth. The character and relation of all these deposits to the newer drift would at once suggest to any one acquainted with the gold-fields of Victoria, the existence of runs or leads in their deepest parts or gutters; for, from the fact that they are all composed of the same kind of rock material as the newer drift, there is no reason why they should not be equally auriferous. But yet, on comparing the relative conditions under which deposition of water-worn material takes place in water-courses—river and creek channels—which latter the Victorian deep leads unmistakably represent, we find great differences; namely, whilst in a continuous water-course, with evenly falling bottom, the current is steadily onward, deposition takes place all along, and—leaving exceptions, caused by turns and local obstructions, unconsidered—the heaviest material settles in the deepest part, it is not so in a lake. There the current of the water of a river, or any smaller water-course, on entering at one end, or any point round the circumference of the lake, gets suddenly checked, either on account of the surface expanse or the depth, or both combined, of the stagnant mass of water, and the consequence is that the heaviest of the water-worn material (including, with regard to both the newer and the older drifts, most of the gold), settles along the side of the lake-basin, whilst towards the centre of the latter there is gradually less finer material deposited. And this process goes on till the basin is ultimately filled up, though towards the other end or outlet of the lake the deposited material will then consist of an increasing thickness of poor and light stuff at the bottom, and a thinning stratum of heavy at the top. Of course the more inlets or sources of supply the lake has, the more they vary in strength, the more irregularly they are distributed around the margin of the lake, and the nearer its outlet, the more irregularity will be observed in the arrangement of heavy and light material towards the latter part and the centre. For these reasons, therefore, the old deposits of the lake-basins mentioned do not, in Ulrich's opinion, contain deep leads in the true meaning of the term, but what he thinks very likely is, that a certain width around the circumference of each deposit is auriferous and payable, or, perhaps, richly so—(there may be more than one layer of wash-dirt)—in front and near the mouths of old, or of those present main water-courses, which seem also to have been the sources of supply in olden times. And thus, these sides would, respecting the Manuherikia basin, for instance, conform with those of the present upper drift workings (Tinker's, Drybread, St. Bathan's, &c.). Only in cases of very circumscribed basins, there would be chance, especially if the inflowing currents were strong and much charged with material, of coarse stuff and gold being distributed all over the basins, though the heaviest stuff and richest gold would likewise be deposited partly on the inlet sides, partly on those rises on which the currents impinged; and, if these were steep, it would partly also slide down to the deepest parts of the basins. Of this feature, the Blue Spur furnishes, in his opini , a striking example. In a long, but very narrow basin, the gold might also be carried by the current far down the centre, and if supplies came in at places down the sides, such a trough might prove auriferous for its whole or the greater part of its length, just according to the number and position of these supply channels. In this respect, the valley of the

Waipori (false bottom) offers, he thinks, by no means a bad chance. If anything deserves the term "lead," it would be the old drift-filled channels leading into or connecting two or more lake-basins lying in the same line of drainage of the end channels leading towards the sea. Of such leads, some have been wholly or partially removed by denudation —they once existed over our heads; for instance, that between the Blue Spur and the false bottom of Weatherstone Flat, and part of the one that must have supplied the Blue Spur from the N.W., both which, with the denudation of adjoining parts of the latter itself, respectively furnished the gold to Gabriel's and Munroe's Gullies. The cement deposit on the top of the ranges between Milton and Havelock may also represent remnants of denudation of such a lead. However, he is convinced there are some channels of this kind yet existing, which it would be advisable to look for; for instance, two—one connecting the old drift-lakes of Weatherstone and Waitahuna flats, and the other which fed the Blue Spur from beyond Munroe's Gully. In fact, he thinks, there is even a likelihood of the existence of similar deposits in that direction. From what he learned about the Cardrona workings, they certainly seem to represent a true old lead, and so does also a deposit which H. J. Cope kindly informed him of, namely, a succession of cemented gravel hills, commencing at the Eight-mile diggings, Arrow river, at a height of at least 500 ft. above Arrow, and dividing into two branches—one terminating at Roaring Billy, the other at the Arrow river, about one mile from Arrowtown. This lead has in places been worked by adits, and found highly payable. In summing up his observations about the old drifts, Ulrich thinks it not only very promising and advisable to prospect for the old channel between certain of the lake-basins mentioned, but also to test the false bottom of the lake-basins themselves at the places previously indicated. The cheapest and most convenient mode of effecting these trials would, no doubt, be by boring.

Thames.—The following notes are taken from the second report on the Thames gold-fields, by Captain F. W. Hutton. The district included in this report is a narrow strip of land on the right or E. bank of the river Thames, and on the E. side of that part of the Hauraki Gulf known as the Firth of the Thames. It is some 25 miles long, by 2 to 4 broad, the direction of the longer axis being about N. 18° W. Shortland, the principal town, is distant from Auckland about 43 miles by sea. At Puriri, the S. end of the district, the alluvial plain on this bank of the Thames is about 3 miles broad, and it gradually narrows until it comes to an apex at the Kuranui Creek, N. of Grahamstown. The remainder of the country is hilly, the hills having generally very steep slopes, and rising to about 2300 ft. near the head of the Karaka. The sides of the hills are generally covered with slipped ground and vegetable soil; very few precipitous places occur, and with the exception of the beds of the streams or creeks, occasional landslips are the only natural sections to be found. The most important of the creeks beginning from the S. are the Puriri, the Kawaeranga, the Tararu, the Puru, the Waionau, the Pohue, the Tapu, and the Mata. The first two run for the last few miles of their course through alluvial flats; but all the others are mountain torrents almost to their mouths, their beds consisting of the solid rock of the country, generally filled up with more or less rounded boulders. Near the sea, the hills are covered with fern, but in the valleys, and farther inland, by dense forest, which, however, is rapidly disappearing in many localities before the axe of the miner.

Gold had been known to exist at Coromandel, a little N. of this district, in 1852, and it had been regularly worked there since 1862. Rumours had also long existed that gold was plentiful in the Thames Valley, and several Maoris and Europeans had brought specimens to Auckland at various times from 1865. In July 1867, a native chief named Taipari, stimulated by the offer of the Provincial Government of a reward of 5000*l.* for any one who should discover a payable gold-field, employed several men, both Europeans and natives, to prospect his land; and gold was obtained by sluicing in the Karaka and Hape creeks. This was taken to Auckland and shown to the Deputy Superintendent and the Native Commissioner, and at the same time Taipari offered to throw open his lands as a gold-field. Satisfactory arrangements having been made with him, the result was that a block of land from the Hape to the Pukehinau creeks, known as the Karaka block, was proclaimed a gold-field on the 1st August, 1867, and a town was laid out at the mouth of the Kawaeranga, and named Shortland. Parties at once set to work sluicing on the Karaka, Waiotahi, and Moanataiari, but with indifferent results; when, on the 17th August, four men discovered the gold *in situ* in the Kuranui on the face of a waterfall, on the spot now so well known as Hunt's reef. This led to further exploration for quartz veins, and in a month's time gold had been found in about a dozen places. Further discoveries quickly followed. Sluicing was abandoned, and quartz mining recognized as the true industry of the field. So satisfactorily did this turn out, that, at the end of December 1868, or 17 months after the first proclamation of the field, not only had two other distinct districts, Tapu and Puriri, been started, but about 1200 claims had been taken up near Shortland, between 800 and 850 of which were then actually working, and probably 600 of the number had seen gold in greater or less quantities; 27 crushing-machines were on the ground, and 13 others were going up. The yield of gold had exceeded 83,000 oz., valued at more than 200,000*l.*; and the population numbered about 18,000 souls.

Gold is now being worked at Puriri,—in the district between Shortland and the Tararu,—and at Tapu. It has also been found in one or two places between Tararu and Tapu; and as the same geological structure extends over the whole district, there is every probability of its existing much more extensively than has yet been discovered.

The oldest rocks found in the district are a series of dark-blue, more or less arenaceous, sub-metamorphosed slaty rocks of a fine grain, rather closely jointed, but not cleaved. At Tapu, they strike E. 10° S., and are nearly vertical, their dip oscillating to about 80°, in some places to the N., and in others to the S. They here consist of blue, rather friable slates, interbedded with soft brown arenaceous slates, that weather white, and hard green slates traversed by innumerable minute veins of compact white quartz. Near Shortland, a small patch of blue and reddish-yellow ribboned slates is seen on the beach a little N. of Tararu; and again, up the Waiohanga Creek. On the beach, the dip of the beds is 35° S.W. These two are the only localities in the district in which this formation is found. No fossils have as yet been found in these slates, and their age is therefore uncertain. Judging, however, from the lithological characters, they appear to belong to the Maitai series of the South Island (as described by Hochstetter). A few miles north of Hastings, on the coast between the Mata and Waikowhau rivers, these rocks are cut by several dykes, running within a few points E. or W. of N., or about at right angles to the strike of the beds. These dykes are composed of a coarsely crystallized diorite, generally of a dark-green colour, but occasionally red, with white crystals of felspar (orthoclase?), sometimes more than $\frac{1}{10}$ in. long. They also contain as accessories small quantities of magnetic iron and iron-pyrites. These dykes would be called syenites by many geologists, although they contain no free quartz.

The patch of slates on the beach N. of Tararu dips towards a mass of fine-grained yellowish-white felstone containing pyrites, which forms the first point N. of the Tararu Creek. This felstone is not seen up the Waiohanga Creek, and probably, therefore, it is an intrusive mass. In the Tapu district, gold is found in lodes traversing these slates. Pyrites also is abundant in some places, but it is not generally distributed through these rocks. Quartz veins also are by no means so common as in the trachytic tufa.

Gold is found both in the porphyry and in the softer blue tufa, but more abundantly in the latter. This may perhaps be owing to the greater hardness of the porphyry, and to the more perfect crystallization of the pyrites contained in it, which prevent the water percolating freely through the rock and decomposing the pyrites, and so liberating the gold contained in it. The tufa formation is traversed by many dykes of igneous rocks, generally more or less magnetic, some of which seem not to have reached the surface. These dykes may be divided into two classes, viz. dolerites and greenstones. Besides these dykes, there are several masses of what appear to be highly metamorphosed tufa traversing the field. It is highly probable that these dykes influence considerably the direction of the quartz veins; but it would be premature at present to form any opinion as to what effect, if any, they may have on the distribution of the gold, as neither the position of all the dykes nor the richest parts of the field are as yet perfectly known.

The alluvial deposits are of 4 kinds. The oldest is a loose, red, more or less sandy clay, containing rounded boulders of dolerite. It occurs in many places on the tops of the spurs that divide the creeks from one another. On the ridge between the Karaka and the Waiotahi, above the Hauraki Gold-mining Co.'s claim, it reaches an elevation of 1550 ft. above the sea-level. It also, at Tapu, fills up some of the gullies on the flanks of the spurs, as seen in the Hit or Miss and Marquis of Hastings claims. It here contains many rolled agates and cornelians from the tufa, and gold, which latter, curiously enough, is very little worn. The boulder formation on the tops of the hills must have been formed when the land was still under water; but the alluvium in the gullies may have another and more recent origin.

Next in age come the deposits of pumice-sand that underlie the town of Shortland. A shaft, sunk just behind the town, after passing through a marine formation of sand with broken shells about 10 ft. thick, traversed 68 ft. of gravel composed of stones of tufa, dolerite, trachyte, quartz, and occasionally rhyolite and obsidian. It then got into pumice-sand, after penetrating which for 10 ft. it was abandoned. These two last beds are evidently an old river-deposit, and must have been brought down the valley of the Thames when the land was at least 100 ft. higher than at present.

The bed of sand with broken shells belongs to the third kind of alluvial deposits. Up the bed of the Kawaeranga, it is seen to pass into two beds, the lower of which is a stiff blue clay full of shells of *Turbo* (recent species), *Venus intermedias*, *Tellina alba*, and a species of *Mactra*, which, although very abundant in this deposit, is now either extinct or very rare in the neighbouring seas. Upon this rests a bed, 3 ft. thick, of brown clay, only the lower part of which contains shells.

The fourth kind of alluvium is formed by landslips from the adjacent hills; but between the Hape and Waiotahi, it assumes much more important dimensions than landslips usually do. It consists of tufa more or less decomposed into yellow, white, or pale-blue clays, containing boulders of tufa, dolerite, and quartz, which last are sometimes auriferous. Below the Royal Standard claim, on the Karaka Hill, at a depth of 30 ft., kauri gum, pieces of wood, and rotten raupo (*Typha*) have been found;

and nearer Shortland, at about the same depth, an old Maori paddle was dug out in sinking a shaft.

It would thus appear that when the alluvium full of boulders found on the tops of the hills was forming, the land was 1600 ft. lower than at present; that it then gradually rose until it was at least 100 ft. higher than now; and at that time the Thames ran farther N. than Shortland. The land then sank to about 10 or 12 ft. lower than now, and subsequently has again risen to its present level.

Veins and Lodes.—The tufa formation is traversed by a large number of quartz veins of all sizes, and running in all directions,—one in the Portuguese claim, on the Karaka Hill, being quite horizontal. Although there is no point of the compass to which veins may not be found running, still there is a most decided tendency to a more or less N.E. and S.W. direction. Out of nearly 200 veins observed in different parts of the field, the bearings of 90 per cent. were in the quadrant between N. and E., while only 10 per cent. were in the quadrant from E. to S.; N.E., N.N.E., and N. being the most favoured directions, and S.E. by S., S.E., and E. by S. the least favoured. The fact that the three least favoured directions are almost at right angles to the three most favoured ones is sufficiently remarkable. The direction of the veins does not appear to have any influence on the abundance or scarcity of the gold. They vary in thickness from ¼ in. to 14 ft., and as a general rule the smaller they are the more irregular is their bearing and dip. The thicker veins are not so rich as the thinner ones. The larger veins are often laminated, or divided into different layers of quartz by thin bands of clay, or "flucans." The quartz is generally crystallized, the points of the crystals meeting in the centre; but it is also often compact, cavernous, or geodic. The veins often contain chert, red and green jasper, and (more particularly at Tapu) cornelian, chalcedony, and agate. Opal has not yet been found, but may be expected to occur. The jasper is sometimes highly charged with pyrites. Carbonate of lime, both as calcite and aragonite, and carbonate of iron, are also found in some of the veins. In the Lady Bowen claim at Tapu, a reef of pure white calcite, about 2 ft. thick, occurs. Gold is found in the clayey casing of this reef, but not in the reef itself. These carbonates have generally been introduced after the quartz.

Gold is found in every description of quartz, from the most tough and flinty varieties to quite crystalline; and is even reported to have been found in red jasper.

Besides the veins, lodes or reefs of three different characters are found in the district. The first occur only in the slates at Tapu, and consist of a mass of soft, stiff, blue clay, generally 1 to 2 ft. thick, charged with small nodules of quartz. A good example may be seen in the Little Jessie claim at Tapu. The second kind is found in the tufa.

These lodes consist of a tufaceous gangue, thoroughly infiltrated with silica, which also forms nodules, and small veins and strings of quartz through it. The walls of these lodes are not easy to recognize, and the amount of quartz contained in them varies very much. Examples are found in the Golden Crown, Hunt's, and Middle Star reefs. The third kind also occurs in the tufa. These are fissures filled up with fragments of rock fallen into them, and cemented together by a siliceous matrix. Such are Dixon's, No. 1, and the Dawn of Hope reefs.

With the exception of iron-pyrites, which is abundant, the auriferous veins and lodes are, as a rule, remarkably free from the ores of other metals, small quantities of stibnite, blende, arsenical pyrites, and copper-pyrites being the only ores found, and even of these the copper-pyrites and blende are comparatively rare, and, as well as the stibnite, appear to have been introduced subsequently to the gold. The gold is nearly always found in, or associated with, quartz, although probably it also occurs in places in the bed-rock, but encased in iron-pyrites. A series of analyses are necessary to determine this point. The gold in the quartz may be conveniently arranged under two typical forms, which may be regarded as the extremes of a series connected together by many intermediate varieties. Often, however, the two forms may be combined in one specimen.

The first form is when the gold is finely peppered, generally in small grains, but sometimes in flakes, through amorphous quartz. In this case, it is so intimately mixed up with the quartz that it is impossible to doubt that the two were deposited simultaneously, and from the same menstruum. In well-crystallized veins, this kind of gold is often seen to be plentiful in the amorphous or semi-crystalline quartz at the base of the crystals ; but as soon as the crystals of quartz begin to be regularly formed, the gold ceases. This is the commonest form in which gold is seen at Shortland, and it is found in all the best claims, both in the quartz veins, and in the irregular nodules that occur so plentifully in the "mullock reefs" or lodes. The nodules in these "mullock lodes" often show no trace of gold on the outside, but when broken, are seen to be thoroughly impregnated with it. The second form is where the gold lies in fine threads or scales on the surface of the quartz without penetrating it. This is seen only in the smaller veins, generally where the points of the two sets of quartz crystals, starting from either side of the vein, approach so near as almost to touch each other. Here, entangled, as it were, between the points of the crystals, most beautiful specimens of leaf and filiform gold are found, while the quartz on either side is often quite barren. In these cases, it is evident that the gold must have been introduced after the deposition of quartz had ceased ; and as the veins in which it is found are almost always not far from the surface, and the quartz is generally stained red by the oxide of iron, there can be little doubt that the gold is a Secondary deposit, and derived from the decomposition of auriferous iron-pyrites. Many claims in which most magnificent specimens of this form of gold have been found have not paid for working, all the gold contained in the vein being apparently visible to the naked eye; while, when the gold is of the form first mentioned, exceedingly good results are often obtained from stone in which little or nothing can be seen.

It may be taken as a general rule applicable to the whole field, that all the veins and lodes show more gold, and crush better, when taken from the red iron-stained upper portions, and that, as they descend into the blue undecomposed parts, the yield is less satisfactory,—not that they contain a less quantity of gold, but because the undecomposed pyrites contains a large percentage of it that cannot be got out by the ordinary processes at present in use; and also on account of the injurious effect of the pyrites itself on the mercury, preventing it amalgamating with some of the gold that is in a free state, and that would readily be attracted by clean mercury. The pyrites also causes the mercury, when used in the battery-boxes, to break up into very fine globules, which float over the tables and cannot be caught, but which probably carry away with them more or less gold.

The quality of the gold differs considerably in several parts of the field, and even from the same claim it often varies a good deal. Out of 28 assays from various parts of the Shortland district, furnished by the assayer of the Union Bank of Australia, the highest gave 19·5, and the lowest 9·625 carats fine, both being from the Waiotahi Creek; while, from the Lord Derby claim, also on the Waiotahi, some stone yielded nearly pure silver, being only 2·75 carats fine, and worth only 9*s.* 8*d.* an oz. The average of the 28 assays is 15 carats fine.

The following table gives the result of these assays separated into districts, and although they are much too few to give any decided results, they show an unmistakable tendency towards a poorer gold—that is one containing more silver—as they go northwards:—

Locality.	Highest Carats.	Lowest Carats.	Average Carats.	Number of Assays.
Karaka	16·094	16·062	16·078	2
Waiotahi	19·500	9·625	16·094	4
Moanataiari	17·594	14·687	15·937	8
Kuranui	16·594	13·937	15·000	8
Ponga Flat	16·656	12·000	14·328	2
Head of Madman's Gully	14·031	13·656	13·781	3
Tararu	..	..	13·968	1

The gold is very widely distributed through the district, although certain parts appear at present to contain it in more considerable quantities than others; but the mines have not yet been long enough worked to pronounce with much certainty on this point. The fact before mentioned, that probably 600 out of 1200 claims had seen gold, shows well how widely it is distributed through the country, for it must be borne in mind that, unlike most quartz-mining districts, the reefs here are not continuous for far, and that the greater part are but thin irregular veins, so that the country was not taken up along lines of leads only, but *en masse*, nearly the whole of the country between the Hape and Tararu being pegged off. It follows from this that nearly one-half of the surface of the country contains more or less gold *in situ*. Major Heaphy had 31 assays made of quartz from the same number of veins from various localities in the Opitomoko and Tararu creeks, all of which gave more or less indications of gold. Two only showed a trace; while the three highest were 3 oz. 6 dwt., 3 oz. 10 dwt., and 3 oz. 18 dwt. to the ton respectively, the average of the whole being 1 oz. 15 dwt. 8 gr. In none of them could gold be seen with the naked eye. Out of the 1200 claims that have been taken up in the Shortland district, about 150, or 12 per cent., have found gold in sufficient quantity to justify the expectation that they will turn out permanently payable mines, and as time goes on, many more may be added to the number. As nearly the whole of the Shortland district has been taken up, and more or less proved, it follows that about an eighth of its surface, which is some 2000 acres, contains payable auriferous quartz veins.

Of the time when the veins were first charged with gold, Hutton can offer no opinion; but there are one or two facts which make it appear probable that gold is still in circulation through the rocks. In the Star of the South No. 2 claim, at the foot of the Karaka Hill, irregular veins of quartz occur at the junction of the face of the rock with the slipped ground, and these veins contain gold, which must have been deposited, together with the quartz, since the landslip took place. Again, in the Niau claim, above the Hokianga, on the Karaka, open quartz veins are seen partly filled with black humus that has filtered down from the vegetable soil above, and this humus, on being carefully washed, yields fine gold, which Hutton supposes had been precipitated from solution by the organic matter of the humus.

Tapu district.—The Tapu Creek is situated about 12 miles N. of Shortland, and in size about equals the Tararu. At its mouth, it forms a small harbour, available for coasters and small steamers. On this harbour the township of Hastings is situated. Rather more than 100 claims have been taken up in the district, and it has a population of about 500. The N. side of the stream is for the most part covered with bush, and rises to a height of about 950 ft. above the sea. The S. side is almost entirely fern, and does not attain to quite so great an elevation as the other, the highest point in the Golden Horn claim being 880 ft. The N. side is chiefly composed of the blue slates, nearly vertical, and with a strike of E. 10° S. They attain an elevation at the Southern Cross and Diggers' Rest claims of about 810 ft. and are capped by a horizontal layer of white decomposed tufa, stained red in places. These slates cross to the S. side of the creek, but are quickly cut off by two faults, one of which runs N.E. and S.W., and the other N.W. and S.E. The rest of the district is composed of trachytic tufa and breccia. Hutton only saw one dyke in the district, which is situated on the beach on the N. side of the harbour, just where the alluvial sand joins the rock. It runs N.W. and S.E., and is about 10 ft. thick, and composed of pale-green, nearly compact greenstone, with occasional small crystals of hornblende.

Gold has been found in the Black Swan claim, about 6 miles up the river, and recently in the ranges about 2 miles beyond the Panama Route claim, but want of roads has kept these localities back.

One of the most remarkable features of this district is the occurrence of considerable quantities of gold in the decomposed soil on the slopes of the hills. This gold is usually flaky and free from quartz, but sometimes attached to small portions of matrix. It is not at all water-worn. It is probably due to the action of rain, which has slowly washed away the rock, and reefs contained in it, as they decomposed, leaving the gold behind, almost on the spot where it originally occurred. A puddling-machine is in course of erection for washing the stuff from the sides of the hill, and there are good reasons for hoping that it will be successful.

The gold varies much in quality, both from the slates and from the tufa, and the best samples from the latter are purer than the worst from the former; but on the whole, the gold from the slates appears to be the more valuable, as the following table will show:—

Locality.	Highest Carats.	Lowest Carats.	Average Carats.	Number of Assays.
Slates	19·34	17·34	18·50	9
Tufa	18·06	17·31	17·69	4

Puriri district.—The Puriri stream falls into the Thames about 8 miles above Shortland. It is navigable at high water for cutters for nearly a mile, the tide rising about 6 ft. Above this, large boulders in the stream form rapids, and prevent boats and canoes from going any higher. The stream flows for its last 3 miles through an alluvial plain, composed of reddish-yellow and green clays, containing many trunks of trees, but with little or no pumice. At about 2 miles from the Thames, the valley of the Puriri is a mile wide, bounded by low fern-covered hills, composed of trachytic tufa. These hills are about 500 ft. high, and continue at the same altitude for a mile, when they become covered with bush, and rise abruptly to a height of 2000 ft. It is in these steeper hills that the gold has been found. They, too, are composed of trachytic tufa, containing large rounded boulders of dolerite and greenstone. Behind, again, the ranges are still higher, and are probably composed of blue and pink slates, for boulders of these rocks are seen in the stream.

More or less gold can generally be found in the creek by washing; and the few pounds of quartz that have been taken to Shortland to be crushed have given very satisfactory returns. The claims are in decomposing ferruginous tufa, containing boulders of dolerite and dark-green greenstone, or melaphyre. The general direction of the veins is N.E. and N.N.E., but they appear to be highly irregular, and to break up near the boulders. The gold is about 16 carats fine.

Permanency of the Mines.—The question of the permanency of the mines is one of the greatest importance to the colony. The height of the mines above the sea-level varies from a few ft. to about 1800 ft.; and the present sea-level is more than 100 ft. above what it has been in, geologically, quite recent times. The base of the tufa formation is of varying height, as it rests upon the old denuded surface of the slates; but at Shortland, it is probably at some little distance below the sea-level. Many of the lodes are of a most permanent character; and in those claims where only small irregular veins occur, they are so numerous that when one is lost another is almost sure to be found, and so, in Hutton's opinion, there is every probability of all the mines extending to the base of the tufa formation. Whether they will or not pass into the underlying slates remains to be proved; but in one case at least (the Tapu Gold-mining Co.'s reef), this is so, and it is therefore probable that the other large reefs and lodes will do the same; but not, perhaps, the smaller branching veins, which are the effects only of the contraction of the tufa. The few auriferous lodes found as yet in the slates, in comparison with the number found in the tufa, is no argument against their penetrating both formations, for the exposed surface of the tufa is so much larger, and has been so much better explored than that of the slates, that the result could not well have been otherwise.

Some further general remarks are contained in a subsequent report by E. H. Davis, which concludes with the following summary.

The presence of gold in the reefs in payable quantities is not marked by any distinct features, the manager of each claim having a different reason for expecting a reef to turn out well or the contrary. Thus:—(1) In Hunt's and the Kuranui mines, gold is expected when the reef becomes rich in pyrites and the quartz more or less dislocated; (2) in the Long Drive, gold is expected when the reef besides having the ordinary grey flucan, contains patches of a shiny-black greasy compound, which stains the hands a permanent black; (3) in the Golden Crown, it is considered a good sign when the reef contains pyrites, is a dull-grey colour, and is more or less mullocky; (4) Manukau and Cure, the same; (5) Waiotahi,—quartz not too hard and compact, grey flucan and pyrites; (6) Dauntless and Sink to Rise,—reef slightly decomposed, with small leaders of quartz running through it, the whole being a dirty white.

The managers are all agreed on one point, viz. that they cannot, by the experience they have had on this field, give a satisfactory reason for expecting gold in the reefs, and also that they cannot tell yet if any change has taken place below the water-level, as they have not done much work at that depth.

Davis's own personal observations led him to the following conclusions:—(1) Pyrites in the matrix of the lodes is a *sine quâ non;* (2) the hanging-wall or roof need not of necessity carry pyrites, but rather the richness of the reef is increased by the diminution of pyrites in the roof, provided the foot-wall is rich in them; (3) leaders joining the reef on the hanging-wall probably increase the yield of gold for a time: leaders from the foot-wall, seldom; (4) the direction of the leaders in the tufa-sandstone has nothing whatever to do with the auriferous quality, provided the leader runs more or less parallel with the direction of the diorite-sandstone; (5) the free gold will decrease with the depth of the workings, but if the land has been elevated at some previous time for a considerable period above its present level, and consequently the water-level lower, the gold will probably continue down to that depth, but not beyond it: the claims near the beach are already beginning to find the reefs harder, the pyrites more solid, and the yield of gold less; (6) the leaders nearly all being formed by segregation, are particularly amenable to atmospheric agency in liberating the gold.

The processes in use in the Thames mining district, for the extraction of gold from the matrix, were the subject of a report by Professor Skey, dated August 1870.

In the course of inquiries relative to the mining prospects of the district, it was found that great difference of opinion prevailed as to the actual amount of gold that escapes with the tailings from the mills, and that this and several collateral questions could only be determined by experiment. For the purpose of making the required analyses, a small laboratory was erected at Grahamstown. The points to which Skey's attention was specially directed were as follows:—(1) The actual loss of gold in the course of the extraction of the metal from the ore at the different mills; (2) the cause of this loss, and how far it can be remedied; (3) the manner of combination of the gold in different forms of matrix; (4) the effect of the use of sea-water, and water pumped from the mines, upon the machinery employed.

The results of assays of tailings are shown in the annexed table:—

RESULTS OF ANALYSES FOR GOLD OF TAILINGS FROM BATTERIES IN THE THAMES GOLD-FIELD.

No. in Lab. Book.	Name of Battery whence taken.	Name of Claim.	Rate of yield per ton.				Actual yield of original stuff at Mills.	How taken.	Character of Tailings, with General Remarks.
			By Berdan.	By Mortar.	After roasting.	Assay yield.			
			oz. dwt. gr.	dwt. gr.	dwt. gr.	oz. dwt. gr.			
896	Onehunga	Onehunga	0 1 0	1 14	..	..	1 oz., nearly	From heap	Moderately fine.
899	Criterion	Shamrock	0 2 3	..	..	..	Unascertained, small	,,	Mod. fine, pyritous, heap 500 tons.
864	Una	Una	0 2 6	1 20	1 17	..	¾ to 1½ oz.	,,	,, ,, ,, 300 ,,
903	Bull's	Berkeley Castle ..	0 2 10	..	..	0 2 18	1½ oz.	,,	,, ,, ,, 40 ,,
,,	,, ...	,, ,, ..	0 2 11	..	..	..	1½ oz.	From shoot	
904	Onehunga	Scottish Chief ..	0 2 11	..	..	..	1 oz.	,,	
873	Tararu	Golden Crown ..	0 2 14	2 17	2 11	..	12 dwt. to 1 oz.	From heap	,, very ,, ,, 1000 ,,
867	Prince Alfred ..	Young American	0 2 22	2 20	..	..	1½ oz.	,,	Fine, colour reddish ,, 200 ,,
	Goodall's machine								
888	Kuranui	Kuranui	0 3 1	4 7	..	..	1½ oz.	,,	Mod. fine ,, ,, ,, 400 ,,
886	,, ...	..	0 3 16	..	..	..	1½ oz.	From shoot	Fine, colour red.
880	Souter's	Flying Cloud ..	0 3 20	4 0	6 17	0 8 12	2 oz.	,,	,, very pyritous.
877	Tramway	Just-in-time ..	0 4 0	5 17	7 7	..	..	,,	,, ,,
878	Hauraki	Mariner's Reef ..	0 4 7	..	..	..	2 oz.	.. [pit	Mod. fine, very pyritous, 65 tons.
889	Moanataiari ..	Moanataiari ..	0 4 14	..	..	..	½ oz.	From setlng.	
898	Criterion	Waitemata	0 4 14	..	..	0 8 23	1 oz.	From shoot	[reddish.
924	Flora Macdonald	Ladybird & Hnd. of	0 5 1	..	..	..	6 dwt.	,,	Mod. fine, feebly pyritous, colour
884	Hunt's	Hunt's [Frndshp.	0 5 2	8 14	..	..	A little over 2 oz.	From heap	Very fine, had been calcined.
891	Kuranui	Long Drive ..	0 5 9	..	..	..	2 oz.	,,	Very pyritous.
868	Prince Alfred ..	Inverness	0 5 17	6 2	..	..	4 to 5 oz.	,,	Fine, colour red, quantity 50 tons.
879	Golden Crown ..	Golden Crown ..	0 5 19	10 20	10 22	0 12 3	¾ oz.	,,	Very pyritous.
872	Russell's	Little Nell	0 5 20	7 4	..	..	¼ oz.	From shoot	Moderately fine.
883	Hunt's	Hunt's	0 6 10	5 23	..	..	2 oz.	,,	Fine.
927	Una	Una	0 7 14	..	..	..	..	,,	Very fine, feebly pyritous, reddish.
911	Hague Smith's ..	..	0 7 21	..	..	0 8 1	1 oz.	,,	Fine ,, ,,
912	,, ...	Wandering Star ..	0 7 22	..	..	..	1½ oz.	,,	,, ,, ,,
865	Una	Una	0 8 6	14 8	..	..	1 to 2 oz.	,,	,, colour pale-red.
887	Kuranui	..	0 12 22	..	..	..	2 oz.	From heap	Pyritous, quantity 300 tons.
871	Russell's	City of Dunedin ..	0 13 2	.	15 19	..	2 oz.	From shoot	Coarse, non-pyritous, blk.-brown.
866	Tookey's	Belfast	1 13 0	..	14 8	..	5 oz.	,,	Coarse.
,,	,, ...	,, ...	1 5 21	..	17 5	1 9 2	4 to 5 oz.	From heap	Rather coarse, pyritous, 60 tons.
897	Golden Crown ..	Golden Crown ..	1 19 18	..	..	..	..	From Perry's heap.	,, ,,

Only one series of experiments was performed for ascertaining the relative effects of the use of mineral, sea-, and rain-water, in the process of amalgamation. Some tailings from the Inverness claim were used, and were, as usual, well mixed before being divided off for the several experiments. Every care was used to ensure the same conditions in working with the various waters—the same head of water, speed of delivery, &c. The mineral water was prepared by dissolving 6 gr. protosulphate of iron (crystallized) in the gallon of water, prior to use, this being the most common and prejudicial salt existing in the shaft-water of the various companies. Results:—

	Rain-water.	Sea-water.	Mineral water.
	dwt. gr.	dwt. gr.	dwt. gr.
Gold per ton ..	8 17	8 14	6 1

The following general results appear from Skey's experiments:—

1. The amount of gold-alloy separable by an almost exhaustive amalgamative process from numerous samples of tailings taken quite indiscriminately from this field has varied from a minimum of 1 dwt. 14 gr., to a maximum of 1 oz. 19 dwt. 18 gr., as calculated upon a ton of the sample; while the assay yield has been 2 dwt. to 1 oz. 9 dwt. 2 gr. of pure gold per ton for the same samples respectively.

2. The yield thus obtained does not bear any fixed or definite ratio to that obtained in the first instance from the same stuff at the batteries.

3. In respect to quality, the gold given up to this re-amalgamation is generally poorer than that which has been taken at the mills by the first amalgamation.

4. Roasting the stuff previous to amalgamation does not, as a rule, raise the yield of gold-alloy; but the gold so obtained is uniformly finer.

In making proper deductions from the results above summarized in reference to the actual loss of gold entailed by the present way of milling, it is necessary to make allowance for the concentration of the stuff in passing through these mills. The amount of this is not a fixed quantity, but varies with the kind of stuff, the degree of fineness to which it is crushed, the volume and fall of water used, and mode of settling. It would be difficult, therefore, to do more than make a vague allowance for this loss; and this is stated by several of the managers of the batteries at 30 to 50 per cent. upon the stuff before crushing. The experiments were confined to the testing of the actual loss in earthy matter incurred by the mode of sampling, the greatest amounting to 45·3 per cent., while the lowest was 20 per cent. On the whole, therefore, and considering that the larger proportion of gold lost will remain with the coarser portions of the earthy matter saved, it will be proper to reduce the figures in the fourth column, to about two-thirds of their value, in order to get an approximation to the actual loss of gold upon the actual quantity of stuff crushed. Subject to the reductions consequent upon making these allowances, the loss of gold for many of these batteries amounts to 30 or 40 per cent. upon that capable of being extracted by careful and prolonged amalgamation, or to 35 and 45 per cent. on the quantity actually present in the stone, as shown by assay.

Compared with the loss experienced on other gold-fields, where amalgamation in the process used, this does not appear excessively high. Still, it is very unsatisfactory as regards our present gold-saving arrangements, to know that we are frequently throwing away nearly as much of the precious metal as is saved, and with a view to the reduction of these losses, the main causes of this loss will now be considered.

The principal cause of loss may shortly be stated, for this and other gold-fields where amalgamation is relied on, as the want of perfect chemical contact between the gold-alloy and the mercury employed. However much of this may be due to defects in mechanical arrangements adopted for securing the gold, the result of Skey's investigations certainly shows that most of it is fairly attributable to causes of a chemical nature and which the very best mechanical manipulation could but partly overcome. These may best be discussed and explained, so far as possible with our present imperfect knowledge, by dividing them into those which especially relate to the mercury, and those which relate to the gold-alloy.

1. Regarding the mercury employed for amalgamation. That this substance generally sickens or "flours" when ground up with pyritous rocks, is so well known and so frequently experienced by all managers of batteries, that it would be superfluous to point out that the true chemical contact sought is much impeded or even entirely prevented by such a circumstance. But as several bodies naturally occurring in such rock are capable of inducing this unfavourable state of the mercury, it may be useful, with a view to the adoption of remedial measures, to explain what is the general cause upon this gold-field.

Whatever has been affirmed about the metallic arsenides or sulphides, sulphur and sulphuretted hydrogen, being frequently or directly active in producing this flouring, Skey feels convinced that the greatest enemy to be contended with on this account upon this gold-field is protosulphate of iron [green vitriol]. He does not know that these arsenides or sulphides exercise any direct effect upon mercury; it is only the products of their decomposition which appear so to act. And this decomposition is so slow compared with the ordinary speed of amalgamation, that ere it has advanced far enough to practically effect the yield, the whole of the auriferous stuff would have been passed through the mill. As regards sulphur and sulphuretted hydrogen, the former has not been identified at the Thames in a free state; and even if it were present, by reason of its insolubility, and comparative non-volatility, its effects upon mercury would be slow. The latter is, on the other hand, very rapid in its effects; but its existence is incompatible with the presence of sulphate of iron, a salt pretty generally diffused in wells and shafts, and porous pyritous rocks occupying superficial situations. Taking all this into consideration, Skey inclines to the opinion, that not only in this, but in other goldfields, the greater part of the flouring or sickening of the mercury used is due to the action of sulphate of iron.

Another obstacle to amalgamation is sulphate of copper [blue vitriol], but it occurs far less frequently. The Silver Crown, the Golden Crown, and Long Drive claims, and other claims around these, being the most likely places for it. This salt, however, is not more to be dreaded than the sulphate of iron; indeed, where the copper salt occurs, the iron salt will also occur, and in preponderating quantity. Both these salts act, Skey believes, by forming subsulphates of mercury and iron or copper, which persistently adhere to its surfaces.

2. Want of contact, owing to the composition and properties of the gold-alloy itself. In regard to the average composition of these alloys, an analysis of 4 Thames specimens, from as many different localities, showed that in 3 of them the metal antimony occurred in very sensible quantity. Skey found by direct experiment that antimony is not a metal which readily amalgamates; it is pretty certain, therefore, that it would communicate something of its negativeness in this respect to whatever gold-alloy it might occur in; indeed, he observed from his own experiments, the very slow rate at which these kinds of alloys do amalgamate. Regarding the properties of these gold-alloys themselves in more intimately affecting the chance of true chemical contact, a hitherto quite unsuspected one has been discovered in the course of these investigations.

It has become apparent that the surface of native or artificially prepared gold, even of extreme fineness, energetically absorbs sulphur or sulphuretted hydrogen. When these surfaces are so affected, they absolutely fail to have such contact with mercury as to enable the metals to amalgamate: at least such is the case at common temperatures; but they again do so readily when treated with cyanide of potassium, free chromic acid, or chloride of lime. Raising their temperature to a red-heat also renders them amalgamable, whether or not cooled before the introduction to the mercury; but the heat of boiling water does not restore the affinity of the surface for mercury.

Several specimens of native gold from this district, and from others where the gold is exceedingly pure, show no disposition to amalgamate on contact with mercury, while others are only very partially affected. Nor is it promoted or facilitated in any instance by giving them contact for a lengthened time with boiling water. So that this non-amalgamation cannot be referred to the intervention of bubbles of air adherent to their surfaces. In these cases, as in those previously cited, contact with solutions of cyanide of potassium renders them easily and quickly amalgamable, and so also heating them, except where very cupreous, when the oxide of copper forming by contact with air at high temperature, acts as an invisible varnish. All the specimens chosen for experiment were free from any discernible ferruginous or other stain.

Comparing the reaction of artificially sulphurized gold with that of various specimens of native gold, leads to the assumption that in many cases where the amalgamation of these specimens is slow, or does not take place, the obstacle is sulphur, most probably existing in combination with gold as an aurous sulphide. The bearing of these results upon the subject under investigation is obviously important, as the exercise of this hitherto unsuspected property of gold must have a very prejudicial effect upon the amalgamation processes as practised in all the reef workings. Sulphuretted hydrogen is too common a substance, or at least the materials required for its generation are too widely spread, to allow of the hope that any larger portion of the exposed superficies of our native gold has not been affected by it to a greater or less extent, and so rendered to a corresponding extent unamalgamable.

3. As the principal cause of the flouring [sickening] of mercury upon these gold-fields is the presence of sulphate of iron in the reef-stuff, and as this salt is freely soluble in water, one way of preventing the mercury being affected in this manner is to wash the auriferous stuff impregnated with this salt, prior to stamping. Whether such a process could be profitably used is a question for experience to determine. To a certain extent, where good water is used for the stampers and tables, the ill effects of the metallic sulphates present in the reefs are diminished. The use of water for these purposes containing any notable quantity of sulphates, acts even more prejudicially than the sulphates naturally existing in the stuff itself, even were they never so abundant. The greatest possible quantity of good water that the incline of the copper plates will safely allow, should be employed, since the solution of these metallic salts is thereby weakened, and so correspondingly less productive of harm.

The yield of gold on the Thames gold-field for March 1871 was as follows :—

Claim or Company.	Stone crushed.			Amount of Gold.		
	tons	cwt.	lb.	oz.	dwt.	gr.
Alburnia	70	0	0	155	10	0
All Nations	290	0	0	1,284	0	0
Ashley (tribute)	21	0	0	26	15	0
Alliance (Tapu)	60	0	0	*33	12	12
Berkeley Castle (tribute)	12	0	0	6	0	0
Better Luck	10	0	0	9	17	0
Bendigo Independent	17	0	0	23	10	0
British	6	10	0	8	13	0
Best Wrinkle	20	0	0	37	0	0
Beehive	4	10	0	6	4	0
Ballarat and Rising Sun	30	0	0	103	0	0
Caledonian	1,370	0	0	*32,437	9	0
City of Glasgow and Black Angel	90	0	0	21	12	0
Christmas Box (Coromandel)	10	0	100	35	15	0
City of London	42	0	0	41	0	0
Coromandel, sundries	..			40	0	0
Candlelight, No. 1	47	0	0	148	0	0
City of Dunedin	70	0	0	82	0	0
Count Von Bismarck (Coromandel)	3	0	0	7	17	12
Cock-a-Doodle	40	0	0	34	0	0
Cape of Good Hope	10	0	0	8	5	0
Clyde and Tyne	8	0	0	4	15	0
Crystal Palace	6	0	0	*8	17	0
City of Hamburg	6	0	0	6	0	0
City of Dunedin Extended	4	0	0	*1	9	12
Coulabah	10	0	0	11	0	0
Dixon's No. 1	130	0	0	213	14	0
Eveline	20	0	0	*13	13	12
Excelsior (Coromandel)	15	0	0	80	0	0
Eldorado (tribute)	62	0	0	146	0	0
Golden Anchor	18	0	0	18	0	0
Golden Crown	487	0	0	910	19	0
Giant (Coromandel)	5	0	0	7	10	0
Great Britain and Brunswick	9	15	0	2	10	0
Globe	4	10	0	2	4	0
Gibraltar	60	0	0	61	0	0
Harbour View (Coromandel)	12	0	0	71	6	0
Inverness (tribute)	52	0	0	174	0	12
Imperial Crown (tribute)	69	10	0	207	0	0
Indomitable	20	0	0	4	15	0
Junction	150	0	0	340	12	0
Kuranui Creek (tribute)	50	0	0	108	0	0
Kuranui Company	700	0	0	545	0	0
Kerry	4	0	0	1	18	6
Lady Bird and Hand of Friendship	750	0	0	277	0	0
Last Chance	13	10	0	5	0	0
Little Republic (Coromandel)	6	0	0	12	0	0
Long Drive	300	0	0	842	0	0
Moanatairi	897	0	0	944	14	0
McDonald's Lease	52	0	0	3[illegible]	0	0
Morning Star	80	0	0	281	19	0
Montgomery Brothers	3	0	0	21	10	0
Multum in Parvo	20	0	0	25	10	0
Middle Star	2	0	0	25	0	0
Manukau	30	0	0	147	10	0
Mary Ellen	0	0	30	9	0	0
Moa (tribute)	41	0	0	18	18	0
New May Moon	60	0	0	*127	0	0
Nonpareil	345	6	8	869	12	12
Pride of York	9	0	0	20	16	0

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* Means that the quantity stated is in melted gold.

These returns show an average per ton on the whole quantity crushed during the month of March of 5 oz. 2 dwt. 20 gr.

Claim or Company.	Stone crushed.			Amount of Gold.		
	tons	cwt.	lb.	oz.	dwt.	gr.
Poverty and Charleston	50	0	0	38	0	0
Providence (tribute)	18	10	0	50	10	0
Pride of Karaka (tribute)	0	0	60	*45	11	2
Point Russell	81	5	0	23	10	0
Queen of Beauty	39	0	0	67	10	0
Red, White, and Blue	161	0	0	197	10	0
Royal Charter	40	0	0	16	0	0
Royal Oak (Coromandel)	15	0	0	51	0	0
Rover	12	0	0	8	10	0
Red Rose	4	0	0	3	0	0
Specimens at Spencer's	0	0	25	25	10	0
Sundries at Spencer's		..		25	11	0
Swedish Crown (Coromandel)	14	0	0	*34	12	0
Shotover	600	0	0	190	0	0
Sundries		..		1,000	0	0
Tookey's (tribute)	59	0	0	84	0	0
Tweedside (tribute)	16	0	0	21	14	0
Tapu Gold	30	0	0	23	0	0
Tokatea (Coromandel)	130	0	0	721	0	0
Te Kooti	1	15	0	2	10	0
Una	289	0	0	773	0	0
Union	79	10	0	132	8	0
Vale of Avoca	45	0	0	*97	12	0
Waitemata	350	0	0	291	0	0
Waiotahi (tribute)	5	0	0	4	0	0
West Coast	5	0	0	25	0	0
Wild Missouri	20	0	0	7	0	0
Total	8,790	13	9	45,200	11	8
February Returns	7,074	2	70	30,749	16	9
Increase in March	1,716	10	51	14,460	14	23

Westland.—S. Herbert Cox, in his report on the Westland district, dated November 1, 1875, divides the workings as follows:—(1) Reefs, (2) cement workings, (3) alluvial workings,—(*a*) workings on slate bottom, (*b*) workings in conglomerate formation, principally upon brown sandstone bottom, but also on false bottoms at Ross, &c., (*c*) workings in glacial drift, (*d*) workings in black sand beaches.

1. The reefs which are being worked to the best advantage are those of the Inangahua, in the vicinity of Reefton. Their general strike is a little W. of N., not differing greatly from that of the beds themselves. To take the Wealth of Nations for an example. This mine is situate on the S. side of the spur which forms the left bank of Murray Creek, and is on the same line of reef as the Energetic Co., whose lease is on the other side of the spur. The strike of this reef is in a direct line with that which has been found at Rainy Creek, and which is now being opened up. In the main workings of the Wealth of Nations the reef has widened out to considerable size, and has proved uniformly good throughout. A second reef has lately been found here, striking S. 10° E., and dipping E. 10° N. This has been sunk on with an inclined shaft to a depth of 60 ft., where it becomes vertical, and eventually takes a trend to

the W. If, then, the other lodes be taken as the true lodes of the district, this is a counter-lode. As a rule, the reefs of this district do better when standing in a more or less vertical position, the flatter ones being generally the poorer; but no record of mining operations appears to have been kept.

In the Taipo Ranges, the reefs are occurring in the lower beds of the Maitai series, which Cox believes to be identical with the auriferous series of Reefton. Here they are striking N.E., and crushings have given as much as 5 oz. 6 dwt. of gold per ton, but this, confessedly on the part of one of the prospectors, was from picked specimens. In all the alluvial workings upon a slate bottom, coarse and angular gold is found, frequently attached to quartz, and this must of necessity have been derived directly from reefs. Where gold has been so found, it is only necessary to prospect carefully to find the reef. Many reefs have been found, as at Moonlight, &c., but they do not seem to have yielded gold in any quantity from their first crushing, and consequently have been deserted, and in many cases they have been left alone without being subjected to even so small a test as one trial crushing, simply because gold cannot be seen in hand specimens of the reef broken off.

2. Cement.—These beds, which consist of quartz gravels in a consolidated condition, occur in connection with the coal series. They vary from 1 to 6 ft. in thickness, and have their greatest development at Cement Town, stretching from there to the head of Lanky's Gully. They also appear associated with the coal measures at the Abbey Rocks, but whether auriferous there is not known. They are undoubtedly a river wash of the age of the coal with which they are associated, and the occurrence of gold in them is both strange and interesting. The gold appears in the lower portion of these beds, but whether as leads, or pretty regularly disseminated over the whole area, can hardly be considered as satisfactorily settled at present. But a small quantity has been worked, and the machinery used for crushing, &c., has been of the most primitive character; and, if attempts to work it up to the present time have not been successful, Cox is inclined to think that it has hardly had a fair trial. It is proposed to put a tunnel through the whole extent of this bed from Lanky's Gully, with the view of determining the prospect to be got throughout.

3. Alluvial Workings.—(*a*) On the slate.—These require but little attention on their own account. They occur in all gullies cut in the auriferous series, and the gold is generally coarse, frequently associated with quartz, and evinces having only travelled a short distance.

As a guide in the search after reefs, the gold found under these conditions is valuable, it being the only class which points to the immediate vicinity of a reef. Round Reefton, workings of this sort may be seen in almost every gully. At Moonlight, coarse gold is also got, and again in Black Ball Creek, at Bell Hill, Seven-mile Creek (in the Taipo Ranges), Butcher's Creek (Kanieri), in some of the creeks surrounding Mount Greenland, and in McDonald's Creek, at Lake Mapourika. In none of these cases, except at Reefton and the Taipos, have auriferous reefs been as yet found, although it is absolutely necessary for them to be here for the gold in the creeks to be derived from.

(*b*) In the Conglomerate Formation.—This heading comprises a very large proportion of the sluicing claims of the district under consideration. They are universally to be found in the gullies, every one of which has been tried with better or worse results, as the case may be. The bottom which has caught the gold throughout this formation is the brown sandstone, which the conglomerates overlie quite conformably, and through which a colour of gold can be got at almost any point. It is, however, only in the gullies, where these conglomerates have undergone a process of natural sluicing, that the gold is sufficiently concentrated to pay for extraction.

At Ross, the gold in this formation has frequently been worked more upon terraces, and generally upon false bottoms, as many as 6 of these occurring in the district. O'Connor has compiled a very valuable map of this district, showing the elevation above sea-level of these various bottoms at different points, with a view of settling disputes between the various claims on the subject of drainage. It is, however, invaluable for other reasons, giving much information which even now it would be impossible to obtain, and in a few years still less opportunities will offer for obtaining any history of the workings of a few years back.

(*c*) In the Glacial Drifts.—At places, as at Hokitika, the Greenstone, &c., extensive and rich claims have been worked in these beds, tons of gold having been obtained from them. These are principally interesting, inasmuch as they must owe the origin of their gold, in all probability, to the slates which occur beyond the metamorphic zone, or, in other words, to the lower beds of the Maitai slates, of which the glacial drifts are chiefly composed; and they point to the occurrence of a far more extensive tract of auriferous ground than that represented by the Taipo Range, which is the only point at present at which auriferous reefs are known in these beds.

(*d*) In the Black Sand Beaches.—These sands are derived from the crystals of magnetic iron, which occur disseminated through the chloritic schists. Cox thought it possible that gold might occur associated with these *in situ*, but Skey's analysis has proved that this is not the case. The gold, then, must have been derived from the Maitai slates, which are brought down in such immense quantities from the glaciers. The diggers generally have an impression that the gold runs in "leads" through the sand, but Cox believes this idea to be erroneous, as there is no reason why it should occur in leads, and absolute observation tends far more to make it appear that it has simply been deposited in patches.

This section may suitably conclude with the following communication, kindly made by Warden J. Allen, Picton, Marlborough, in response to an application for information.

"I give you a rough hasty sketch of the rise, progress, and apparent decline of these (Marlborough) gold-fields as follows:—

"My district comprises the following subdivisions, viz. the Peloras, or as it is better known by the name of the Wakamarina gold-field, the Queen Charlotte Sound gold-field, and the Wairau Valley gold-field. I take the oldest first, the Wakamarina gold-field. This was the first gold-field discovered in the county of Marlborough. Some time about the year 1864 some prospectors found a deposit of gold on the banks of the Wakamarina river. The finds were rich, the news soon spread, and in a short time we had a considerable rush of miners and others to work the ground. At first it might almost be described as a 'fossickers' gold-field'; rich deposits of gold were found in the bed of the river and deposited in the crevices of the rocks in places forming the banks of this river. The principal labour required was to scrape out the deposits of gold from the crevices. As this supply became exhausted, practical miners took up claims along the banks of the river and of the tributary streams flowing into this river; for a long time the claims proved rich.

"The Wakamarina Valley, to which this gold-field has almost exclusively been confined, is a narrow valley of about 15 miles in length, with branch gullies opening out here and there on either side, out of which gullies the various tributary streams flow into the Wakamarina river. The country for the most part consists of steep precipitous hills, with spurs more or less steep from the main range to the river. Occasionally may be found a small extent of level land, or of comparatively level terraces. At the time of the first discovery of gold, the whole of this country was covered with dense bush, and of course destitute of roads. The work of searching for gold in country of this description was very heavy, and proved discouraging to all who were not old hands, or working on good gold; the consequence was that nine-tenths of the population left the district on the discovery of a new and more accessible gold-field on the west coast.

"I need not trouble you with any details of work from that time to the present date. It would appear that you wish for information concerning the work as at present carried on; my report will therefore now be confined to present operations. You ask for special reports concerning the

Atmospheric Cylinder Co.'s work. I am sorry to say I can give you no information about the matter. I have never seen the cylinders at work. After conveying the machinery to the claim on the Wakamarina river at a considerable cost, the directors disagreed amongst themselves, and no further work has been done. The machinery remains unused on the ground until better arrangements are made. I am inclined to think that this kind of apparatus is not at all adapted to working in rapid gorges of rivers; it appears to be more suitable for prospecting river-beds and wet claims.

"The whole of the Wakamarina district is to the present time an alluvial gold-field. Parties have been out searching for reefs; but although several have been found in the ranges, no proper means have yet been adopted to test their value. There is a great amount of risk and expense connected with this work, and working miners are not in a position to incur this expense. It is simply a matter of time. There is no doubt that good gold-bearing reefs will be found: it requires a judicious combination of honest practical men and capital to develop the resources of a district like this. Probably it would require a large outlay of capital to properly test the reefs; as the country becomes gradually opened up, this working expense will be proportionately diminished. Many small parties of miners are at work, either sluicing on a small scale, or working ordinary claims by the usual appliances of sluice-boxes, &c., and some of the parties are doing well. The ground is patchy; the gold is not evenly distributed; occasionally therefore good finds are reported.

"A company, called the Wakamarina Hydraulic Sluicing Co., are about starting to work their ground. For some months past they have been engaged in constructing water-races and a tail-race. They lease 10 acres of ground from Government not far from the river, and taking up part of a terrace on which good gold has been found. A dyke runs through their claim that they consider to be portion of the old river-bed. This dyke is filled up with good-looking wash-dirt, amongst which they hope to find payable gold. They intend to bring about 8 or 10 heads of water to work on their claim. I enclose you two photos., Nos. 1 and 2, No. 1 is the tail-race, No. 2 the upper portion of their claim. The tail-race is about 280 ft. long, average depth 32 ft., with a width at base of 2 ft. 6 in., mostly cut through a belt of solid rock. This belt of rock appears to divide between the old and the new river-bed. The tail-race has a good fall into the new river-bed, and had to be cut through this belt of rock to get an outflow for water and tailings. The water-race will be about 4 miles long and taken through rough bush country. The gold is to be saved by the usual appliances of sluice-boxes. The ground to be sluiced consists of a surface of clay, and below this coarse gravel plentifully intermixed with clay and large boulders. Should this company be successful in their work, I have no doubt several other companies will shortly be formed.

"I enclose you photo. No. 3 of Trent, Diamante & Co.'s river claim. They propose to divert the course of the present stream of the river Wakamarina for a distance of several chains, and to drain the portion of the river-bed from which the stream is thus diverted by powerful Californian pumps. They hope to find gold deposited at the bottom of the river-bed. I am afraid their appliances are scarcely sufficient for the work they have undertaken. The bed of the river is composed of shingle, the bottom varying in depth according to the inequalities of the bed-rock. In some places the bed-rock is washed nearly bare, in others there would be a considerable depth of shingle. The difficulty experienced will be that the water manages to drain through the shingle, however carefully they construct their dam, and of course drains into their working from adjacent hills. In rainy weather the river rises very rapidly, and the current is strong, carrying all before it not strong enough to resist its power. I do not think under any circumstances this company will be able to bottom their claim until next dry season.

"The only way now to work these alluvial diggings profitably is, where water can be obtained at a reasonable cost, to form companies 'strong in capital' to work on an extensive scale.

"The next subdivision of my district, the Queen Charlotte Sound gold-field, will not require a long description. This is a quartz-mining district. On reference to the Admiralty chart of these sounds, you will understand my description when I say that this gold-field extends on the northern side of the Sound from Separation Inlet to Port Gore. At only two places in this district are there any companies at work, viz. at Ravenscliff, near Jackson's Head, and at a point bearing the local appellation of Golden Point, nearly opposite to Picton Harbour. With regard to the Ravenscliff company's claims, I can only refer you to their report published in London; you can, no doubt, obtain all further information from their manager in London, No. 50, Old Bond Street.

"With regard to the Golden Point claims, there is little to report. The result of their working to the present time has not been satisfactory. The claims have changed hands two or three times. The present new company appear determined to give the mine a fair trial. They are now sinking a shaft about 250 or 300 ft. deep; they then intend to drive, in order to open up any reefs or gold-bearing leaders. Good stone has been taken from a shaft when worked by the original company, but the present company have abandoned this old shaft on account of obstruction of water. They have steam pumping apparatus on the ground, and whatever may be the result of their labours they deserve success. This gold-field is situated many miles from the Wakamarina.

"The third subdivision of my district is situated in the Wairau Valley. A high range of precipitous hills divides this district from the Wakamarina. The Wairau Valley is an alluvial gold-field, and comparatively a new gold-field, although it has been a well-known fact that gold has been found in some of the gullies on the north bank of the river Wairau nearly twenty years ago. The present field extends from Birch Hill Creek to Lambert's Gully, a distance of 15 or 20 miles. Gold is found in almost all the gullies on the north bank of the river Wairau. The small area of flat land and terraces extends from the river bank to the spurs of the main range; this is all open fern and grass country; on approaching the ranges the hills are covered with bush. The gullies are all very narrow. Gold is found in the beds of the different streams and partly up the hillsides. Some of the claims have proved rich. The gold is very patchy, and this country, like the Wakamarina, should be worked by sluicing on a large scale. On the small flats near the Wairau river, working is obstructed by water. The Wairau river-bed is for the most part clean shingle, and of good depth: water would prevent any miners from bottoming. The Wairau is a much larger river than the Wakamarina. The ranges from Arm Chair Creek to the Kaituna, and probably for a much greater distance, are of the same description as the gold-bearing rocks of Otago.

"I forward you this mail, copy of Geological Map of New Zealand and copy of the Mines Acts in force in this colony.

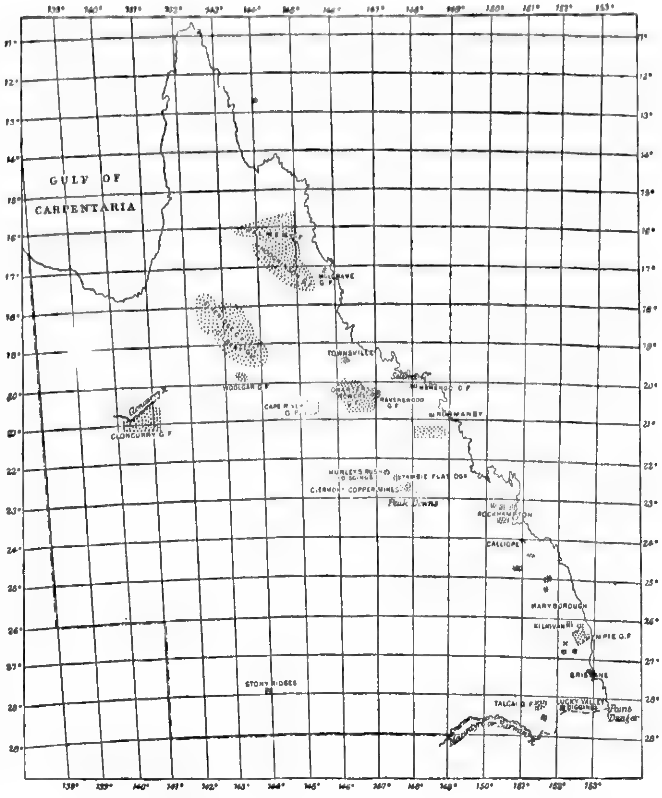
"You need not return the photos., map, or book; I shall not w them again. I am sorry I have not more extensive workings to describe. —I am, yours obediently, J. ALLEN, Warden."

QUEENSLAND.—The first discovery of gold in Queensland was made at Cananoo, about 35 miles from Rockhampton. In 1867, the Queensland Government offered rewards varying from 200*l.* to 1000*l.* for the discovery of new and paying gold-fields in the colony. This led to the finding of several early in the year, and, in September, of Gympie Creek, a locality about 130 miles from Brisbane, where a nugget weighing 100 lb. and valued at 4000*l.* was picked up near the surface. There are at present upwards of 20 gold-fields in the colony, comprising, in the Northern division: Broughton, Cape River, Cardwell, Charters Towers, Cloncurry, Cooktown, Etheridge, Gilbert, Hodgkinson, Normanby, Palmer River, Ravenswood, Townsville, Western Creek; Central division: Boyne, Calliope, Peak Downs, Rockhampton; Southern division: Brisbane, Burnett, Gympie, Jimna, Kilkivan, Leyburn, Lucky Valley, Maryborough, Nanango, Pikedale, Talgai, Tenningering, Warwick.

These fields embraced 662 distinct quartz reefs proved to be auriferous, and 3100 sq. miles of auriferous alluvial and quartz ground worked upon in 1876. In that year, the quantity of material crushed was

76,634½ tons, producing 123,038 oz. 1 dwt. 18 gr. The average yield was 1 oz. 12 dwt. 3 gr. of gold per ton; the highest was 3 oz. 19 dwt. 17 gr.; the lowest, 3 dwt. 14 gr. The highest price of the gold was 4*l.* 2*s.* 6*d.* an oz., the lowest was 3*l.* 2*s.* The export of gold bars in that year to New South Wales was 40,242 oz., value 143,764*l.* Gold-fields have been found

FIG. 21.



SKETCH-MAP OF QUEENSLAND GOLD-FIELDS.

here and there on each side of the main dividing range which separates the eastern and western waters, and on the spurs of the range which forms the watershed to the Gulf of Carpentaria.

The Queensland trophy at the Paris Exhibition of 1878 included an obelisk representing 2,646,916 oz. of gold, value 10,587,664*l.*, the export from the colony from 1868 to September 1877. The details of the exports are officially stated as follows:—

		1864.	1865.	1866.	1867.	1868.	1869.	1870.
Gold Dust	Oz.	22,037	25,339	22,916	49,092	165,801	138,221	136,773
	£	83,292	92,938	85,561	189,248	593,516	523,045	489,539

		1871.	1872.	1873.	1874.	1875.	1876.	1877.
Gold Dust	Oz.	125,295	153,021	136,431	329,476	359,076	334,534	385,576
	£	449,170	540,284	507,947	1,191,488	1,383,710	1,284,165	1,452,396
,, Bars	Oz.	46,642	32,998	58,464	46,111	32,439	40,242	44,528
	£	167,737	120,112	209,593	164,583	114,723	143,764	158,707

Charters Towers gold-field.—The geology and mineral resources of the Charters Towers gold-field, and the district between it and the coast, were made the subject of a report by Robert L. Jack, in 1879.

Alluvium, recent.—In the gravel of the rivers on the seaward side of the Coast Range, gold in small quantities has been found. During January and February 1878, parties working on the Ross river, near the Kennedy Hotel, were rewarded by the discovery of some little nuggets; but nothing took place deserving the name of a rush, and the place has already been abandoned. Discredit has, as usual, been thrown on the genuineness of the discovery, but Jack sees no ground to question the possibility of the occurrence of gold on the coast-side of the range, in spite of several unsuccessful attempts on his own part, and a general disbelief prevalent among practical miners. The gold at the Kennedy Hotel was probably derived from Mount Stuart.

On the other side of the range, the case is different. Most of the flats on the inland side of the range have yielded more or less gold; but the so-called alluvial workings of this region have been in many cases mere washing of the gravel in the river-beds, taken by preference from sheltered holes and crannies among the bed-rock. Some narrow strips of alluvion on creeks to the S. of Charters Towers have been very thoroughly explored, and have yielded gold in considerable quantities. Among these are the Seventy-mile, a tributary of the Broughton, and the streams among the mountains lying between the Seventy-mile Creek and the Clarke branch of the Broughton—viz. Fenian Gully, Two-mile Gully, Eight-mile Gully, &c.

In the last-named region, miners were working alluvion in 1872, when Charters Towers attracted their attention, and induced them to make the prospecting tour which resulted in the discovery of a new reefing district. The European diggers shortly afterwards rushed in a body to Charters Towers, and the Chinese flocked to the abandoned field in such numbers that there are said to have been at one time 7000 of them at work on the Two-mile Gully alone. The place at present has the appearance of having been most thoroughly turned over, a great deal of surfacing having been done in addition to the washing of the alluvion. At the date of Jack's visit (14th December, 1878) less than half-a-dozen men were at work at alluvion in this range. They were meeting with moderate success, although the difficulties of washing were very great at the time. The dirt had to be carried in bags, sometimes for ½ mile, and washed with water raised by windlasses from shafts on abandoned reefs. The method employed was generally to sink shafts to the bottom of the alluvial gravel, and drive tunnels along the surface of the bed-rock. When discussing the reefs and the palæozoic strata containing them, there will be opportunity of referring again to the surfacing operations.

Narrow alluvial flats on several small streams between the Two-mile Gully and the Clarke branch of the Broughton, have also been pretty thoroughly worked out. Alluvial diggings at Brook's, 8 miles S. of Rishton, occupied, in 1872, 100 men, according to MacDonald's report.

Ever since the opening of the Charters Towers gold-field, a few miners have been working alluvions on Mosman's, Sandy, and Gladstone creeks, and their tributaries; generally speaking, only the gravel in the actual beds of the rivers has been worked. The figures in the Warden's returns are sufficient in themselves to show that after the first rush the reefs alone were systematically worked, the alluvion being left to the casual efforts of the otherwise unemployed. In 1872, no less than 800 men were working alluvions. In 1873 and 1874, the number was reported at 50. In 1875, it had dwindled to 30. Next year it rose to 160; and in 1877, it fell to 20. These figures, however, included men working at deep leads of older date than the recent alluvial deposits. They indicate on the whole, rather the fluctuations in the prosperity of other mining districts than the richness of the alluvion in this. The difference between the gold derived from quartz reefs on the Charters Towers field and the amount escorted must be divided between alluvial and tailings; but it is now impossible to say in what proportions.

Some of the tributaries of the Little Star river, more especially Dry (Scrubby) Creek, have for a good many years attracted a few miners, whose desultory labours have been fairly, but seldom richly, rewarded. One man was at work there as late as September 1878. The workings, so far as could be traced, had all been in the beds of the creeks, where the latter descended to the rolling downs out of a range of mountains composed of quartzite, mica-schist, and hornblendic gneiss. With the view of testing whether the gold was distributed farther to the W., two experienced diggers bottomed in several places on a creek flowing through country of the same character as that at the head of Scrubby and Melon creeks, northward, into the Little Star river, about 3 miles from its junction with the Great Star, and washed a considerable quantity of the dirt, with a purely negative result. Water to wash with was, however, obtainable only with great difficulty at the time, so that a thorough prospecting of the locality was out of the question.

Post-Tertiary.—About 2 miles S. of Millchester, the singular rock known as the Little Red Bluff rises about 100 ft. above the level of the downs. It has a flat top about ¼ acre in extent, bounded by an escarpment about 30 ft. in height. The rock of this escarpment is a grit or sandstone, much stained with peroxide of iron; its N.W. side has been extensively quarried in terraces, and is said to have yielded some gold. The "drift" of the Little Red Bluff, and of the deep lead in connection with it, has been tried again and again for gold. Quite a rush to it took place about 2 years ago, but without much success. The number of shafts sunk attests, however, the earnestness with which success was for a time believed in. From an examination of such shafts as remained open at the date of his visit, and of the wash-dirt, Jack arrived at the conclusion that comparatively few had reached the true bottom of porphyry or granite, and that those who had done so were all near the N.W. end of the lead, where the deposit is shallowest, and where the bottom could be reached at a depth of only about 20 ft. Below the point where the Imperial Creek leaves the deep lead, all the shafts appear to have been sunk only to the base of the bed of white grit, the underlying ferruginous bed having evidently been treated as the bottom. The deep lead to the S.E. of Millchester employed the energies of a large number of diggers on the first rush to the new field in 1872, when a good many made considerable hauls. This lead has more conspicuously paid than any other alluvial working on the field. It deepens across the watershed into a valley draining to the E. If, following the example set at Red Bluff, the grit is to be regarded as a deep lead, it is needless to say that alluvial mining in this district has hardly been begun. It would be advisable, however, to confine operations in the first instance to leads in the vicinity of known auriferous reefs. Gold is more likely to occur in such deposits in hollows of the bed-rock, near the shores of the old lake or inland sea, than in its interior. It may be well to quote as a warning Daintree's observation, that "it is doubtful if any marine or extensive lacustrine beds, except on their shingle margins, have produced, or are ever likely to produce, remunerative workings of free gold, for the simple reason that the majority of the sediments of which they are composed are derived from formations, the greater part of which were non-auriferous."

Tertiary.—A great volcanic outburst, regarded by Daintree as "contemporaneous with the upper volcanic series of Victorian geologists," has overspread with beds of basaltic lava an enormous area between the

Dividing Range and the upper portion of the Burdekin. There is no evidence bearing on its age; but if it be "pliocene tertiary" (according to Daintree), the underlying 60 ft. of clayey strata must be either of pliocene or older date. The geological parity existing between this and the auriferous drifts of Victoria may some day lead to a systematic search for the precious metal below the basaltic capping.

Pre-Devonian [Silurian] metamorphic.—The gold-mines of the district occur without exception inside the metamorphic region. It is worthy of remark that the richest deposits occur in the most highly metamorphosed rocks near their contact with the least metamorphosed rocks of the district. The latter occur to the N. and W. of Charters Towers, their boundary having been traced from the heads of the Broughton river, in a sinuous line northward, to the Burdekin. They consist of quartzites [hardened sandstones of quartz granules], greywackes [hardened sandstones of mixed quartz, felspar, and hornblende granules, with some mica], slates, and shales. The slates do not differ from the shales in mineral composition—mainly silicate of alumina, with a high percentage of peroxide of iron—but simply in being intersected by cleavage planes. Both the slates and the greywackes are, as a rule, highly impregnated with iron, being in places "iron-masked" to such a degree that they might almost be taken for weathered clay-band ironstones. The slates strike, as a rule, N.W. and S.E. They dip at angles of 45° or more, both N.E. and S.W. Indeed, there is every probability that the same strata will be found repeated in a series of sharp folds. The cleavage planes of the slate appear to strike in the same direction as the bedding-planes, and to dip S.E. at about 30°.

Within the area of little metamorphosed rocks, occur several quartz reefs. Two of these, the Great Britain, and the Rose, Shamrock, and Thistle, were being worked at the date of Jack's visit. Both run about 25° W. of N., and underlie N.N.E. The workings in the Great Britain mine were at a depth of about 60 ft. The underlie is about 60°; country, slate; hanging-wall, distinct; foot-wall, never certain; reef at least 7 ft. wide, and contains a good deal of quartz (showing a little mundic and some peroxide of iron) scattered through a gangue of slate or débris. The Rose, Shamrock, and Thistle reef, both in strike and underlie, is parallel to the course of the Great Britain. Crushings from the mines have yielded 2 oz. 7 dwt. to the ton. The line of these reefs does not coincide with the strike of the slates, forming with it at an angle of about 20°.

In the course of the survey, the outcrops of several quartz reefs were seen within the little metamorphosed area. One on the road from the Great Britain mine to Charters Towers runs due N. and S.; another on the Hayman's road, on the point behind Plant's Mill which overlooks the town, runs E. and W.; other two, in the N.W. corner of the area reserved for homestead selections, run N.W. and S.E. (coincident with the strike of the slates). The quartzite beds in some cases so much resemble vein quartz, that prospectors have been induced to sink little shafts upon them. A few yards N. of the old Townsville road, about a mile from Cockfield's, a reef of white amorphous quartz, running 20° N. of E., stands at least 6 ft. out of the ground, with a breadth of about 20 ft. It is pretty free of iron-pyrites, or any foreign admixture whatever, and in short is of the character unfavourably regarded by the miners as a "buck-reef."

The mountainous region whence Melon, Scrubby, and Dinner creeks, and the north head of Cattle Creek, take their rise, is composed of hornblendic schists and gneisses, with some quartzite beds. From this locality must have been derived the gold found in the alluvial deposits of these creeks, where they emerge from the hills. Over the whole of this area quartz reefs are numerous, and the soil is strewn with quartz fragments. A thorough prospecting of the mountainous region, in search of auriferous reefs, may yet lead to better results than the desultory working in the dry beds of the creeks which have hitherto engaged the attention of the few miners who have been employed on this field.

The porphyry range of the Pyramids [Seventy-mile] rises abruptly from the undulating plain of granite near the watershed between the Burdekin and Cape rivers. Alluvion was extensively worked in the gullies of the range and in the streams surrounding its base. On the discovery of Charters Towers field, a rush took place there, and the Chinese occupied the abandoned Seventy-mile field in great numbers, to leave it on the break-out of the Palmer diggings. A little reefing had been done, but was stopped, as was till lately the fashion, on reaching the water-level and mundic. It is likely that reefing operations may be resumed in such a manner as to test the question of the continuance of the gold in the mundic.

A reef (called Swan's) worked to the water-level has recently been taken up. It lies on the N.W. slope of a pyramidal mountain, and runs W. 25° S., underlying at 40° to S. 25° E. The principal shaft had struck the reef at a depth of 60 ft., having passed through a diorite dyke. Sinkings had been made in several places on the underlie along the outcrop of the reef. Samples from a "mullocky leader" of porphyry débris and decomposed pyrites ["brownstone"] in one of these sinkings, are said to have occasionally yielded at the rate of 100 oz. of gold to the ton. Jack dug out two dishes of this, and obtained "colours" in both. The "brownstone" is dark-grey pyrrhotite [magnetic pyrites] with sub-metallic lustre ($Fe_7\ S_8$ = sulphur 39·5 + iron 60·5) coated with brown peroxide of iron. Analysis failed to reveal the presence of arsenic, copper, or nickel.

"Surfacing" operations have seamed the hillside up to the line of reef, but have stopped short there, the presumption being that they ceased to pay at higher levels, the reef being, probably, the source of the greater part of the gold. About 400 yd. E. of and nearly in a line with Swan's reef, is another having a direction of W. 7° S., hading about 45° to S. 7° E., and consisting mainly of angular débris of porphyry, containing quartz with pyrites, and red oxide of iron, about 4 ft. wide. Some of the "brownstone" from the surface is said to have given 13 oz. to the ton, but the workings were stopped on reaching the mundic, a quantity of which lies around the shaft.

About 12 ft. below this reef, another 2 ft. in width occurs, containing a good deal of pyritous quartz. The quartz from the bottom of the shaft is white, and contains much pyrites and some zinc-blende. A tunnel has been driven some 30 ft. into the hill about 300 yd. S. of Swan's reef. No reef appears to have been followed, the tunnel having been driven simply into the decomposed porphyry, the softer and more ferruginous parts (possibly so from the decomposition of auriferous pyrites) in the neighbourhood of joints being taken out. It is a porphyry with reddish blebs of quartz in a buff matrix of decomposed felspar. This stuff is said to have crushed 2 oz. to the ton, the gold being in fine threads, a peculiarity of gold much alloyed with silver.

The experience of the Charters Towers field having proved that the gold continues in the mundic as well as in the "brownstone," the Seventy-mile may yet deserve the attention of reefers. All the creeks surrounding the mountain on which Swan's reef is situated, having proved rich in alluvial gold, search is being made for reefs by surface trenching and otherwise.

The Comstock [Stockholm] reef, one of the "outside" reefs of Charters Towers, occurs in porphyry "country" (matrix of silicated felspar, with large blebs of quartz), near the junction of the porphyry with the slate. The reef is about 5 ft. wide, with an indistinct foot-wall. The hade is steep, about 75° to E. 25° N. The present workings have reached 135 ft. on the underlie. The ore now being raised is a good-looking dark-blue mundic, said to be occasionally 4 to 6 ft. wide. It contains a large percentage of zinc-blende, a good deal of iron-pyrites in minute crystals, a little copper-pyrites, and some galena. In one place, at the surface of the reef, carbonate of copper is seen. The last crushing gave 10 to 16 dwt. Some of the stone assayed at the rate of 9 to 10 oz. of gold to the ton.

Two other reefs adjoin the Comstock to the E., the first bearing S. 35° E., and hading at 65° E. to 35° N., and the second bearing S. 5° W., and hading E. 5° S. Both have been worked a little on the outcrop, in the brownstone.

Old Warrior is another of the "outside" reefs of the Towers field. It occurs in a porphyry country on the W. side of a group situated 2 miles S. of Millchester, comprising the Alexandra, Pacific, Washington, Sons of Freedom, Imperial, and others. It strikes W.S.W., and hades at 33° to N.N.W. In the only claim at present working the mundic has not yet been reached. The brownstone yields 3 to 9 dwt. Claims on the E. side of the road used to give 15 dwt. The reef is about 2 ft. wide, and contains a good deal of selenite. The best gold is said to come from the vicinity of the foot-wall.

Imperial reef lies to the S.E. of the Old Warrior, and has nearly the same bearings. It shows a great breadth of quartz at surface, and is said to have 4 ft. of stone below as a rule. There is a heavy influx of water, requiring constant pumping with an engine. A 5-stamp battery has recently been erected.

A large reef crosses the Bluff track, to the S.W. of the Imperial. It is traceable for a considerable distance from W.N.W. to E.S.E. as a wide vein of quartz, sometimes crystallized. It has been opened out a good deal on its outcrop, and some trial crushings have been made, which are said not to have been very encouraging.

Old Identity reef underlies to the N.W. at 30°. It varies from a few inches in width to 4 ft., the gangue being quartz with some carbonate of lime and some pyrites, also a little bismuth. Barytes occurs on joints in the granite walls. In No. 1 claim, the shaft struck the reef at 60 ft. deep, from which level 130 tons crushed at the rate of 4 oz. 8 dwt. to the ton. In the prospecting claim, 2 oz. per ton are obtained. At the 130-ft. level in No. 1 claim, the granite walls, saturated with water, have swelled out with irresistible force. At the 130-ft. level, between No. 1 and No. 2 claims, the reef is cut by a fault (greasy wall), heading a little to the E., and thrown down 6 ft. on the side of No. 2. Rich mundic occurs in No. 1 claim, in the neighbourhood of the fault, frequently containing visible gold. The reef divides into two or three veins on approaching the fault, and the quartz is crystallized—a somewhat rare circumstance in the reefs of this district. One quartz vein, 3 to 12 in. wide, runs down into the slip, from which it appears that the main fissure had been first filled with its vein, and that the silica and other materials had consolidated before they were broken through by another fissure, in which similar materials were again deposited and consolidated. The supply of vein materials in solution must, therefore, have been kept up for some time.

At the 200-ft. level, a dyke of porphyry, nearly vertical, runs W. 20° N. through the reef. In No. 1 claim, it is 2 ft. 9 in. thick. It thickens in No. 2 claim (to S.E.) and dies out in the prospecting claim (to N.W.), where a clay seam is understood to represent it. Above the dyke, in

No. 1 claim, at least, the quartz is rich in gold. The dyke is traceable at the surface for more than ¼ mile, with a course on the whole E. and W., and a maximum width of 25 ft. It dies out at the E. end (close to the E. boundary of the township of Millchester) and is replaced by a quartz reef in the same line. In No. 1 claim, it runs into, and seems to die out in, the foot-wall. The influence of superficial agents of waste is felt down to about 100 ft. Below that level, the granite is hard. The reef is composed of "mullock" (angular débris of the material "country"), with shoots of quartz, containing auriferous pyrites and some galena. The shoots of quartz are said to run down the reef diagonally from S.W. to N.E.

The Queen, another reef among the most important on the field, situated between Millchester and Charters Towers, bears N.E. and S.W., with an underlie of 30° to N.W. This bearing is quite abnormal in the field—in fact, the Queen may be said to be a cross-course, situated as it is in the middle of a cluster of reefs bearing N.W. and S.E. and underlying to N.E. A vertical shaft cuts the reef at a depth of 208 ft. At that depth a level was driven from the shaft 340 ft. to S.W., through soft "mullock" (broken granite), between well-defined walls. Quartz veins come in and die out in the gangue with apparently no regular system. Specimens of what is considered "2-oz. stone," taken from the S.W. corner at this level, are of compact quartz, with joints and sides coated with chlorite, and pretty well darkened throughout with galena and iron-pyrites.

Sometimes the ores occur alternately in little veins or strings, sometimes in isolated aggregations, while at other times the crystals of both are indiscriminately mixed. The quartz has the bluish tinge (due to silicate of lead?) which is, rightly or wrongly, believed on the field to distinguish auriferous from "buck" quartz. Specimens picked out as examples of stone estimated at "1½ oz." and "better than 2 oz." respectively, differ from the last-described specimens, the former in having quartz of a lighter blue, veined with felspar, less galena, and more steatite; the latter in having both the galena and the pyrites in finer crystals disseminated indiscriminately throughout. Other specimens from this level contain a little gypsum. In some, sphalerite (zinc-blende), galena, and iron-pyrites are associated. One piece of quartz was amorphous except in the middle, where both sides of an open cleft were lined with dog-tooth crystals, the spaces between the crystals being filled up with gold. In another specimen, the gold occurs as an isolated cluster of grains in a mass of milk-white amorphous quartz, of a kind which would be apt to be regarded as "buck," but for the visible presence of gold.

In the Queen, generally, the quartz veins penetrate the foot-wall, a circumstance which is almost peculiar to this reef, and was understood to indicate the presence of a parallel reef below. A drive was accordingly made bearing S.S.E. from the end from the 340-ft. long level, and the hanging-wall of another reef was reached, at a distance of 63 ft. A dyke of porphyry, or perhaps more properly syenite, runs S.E. through the "country," but has not been seen in the reef itself. Small cubes of pyrites occur throughout the matrix as well as in the quartz. During 12 months, 2273 tons of stone crushed gave 2286 oz. The gold averaged 3*l.* 5*s.* per oz.

St. Patrick reef has a N.W. course, and underlies to the N.E. at an angle of 28°. The block has a vertical engine-shaft of 110 ft., and an underlie shaft measuring 580 ft. from the foot of the vertical shaft. For 70 or 80 ft. down the underlie from the foot of the prospecting shaft, the granite country is soft, reddish, and decomposed. The brownstone in the reef went down as far as the granite was decomposed, and gave place to mundic at the point where the granite ceased to be influenced by weathering. The brownstone here was only moderately rich, 2 oz. to the ton at most; but where the mundic was first struck, it yielded 5 oz. The stone now averages 2 oz. The workings now reach the N.E. boundary on the underlie. At the 350-ft. level, is a reef of quartz with mundic 6 ft. in width. The mundic in the mullock (broken granite) between the walls does not carry gold in payable quantities. At the S.E. end of the 450-ft. level, a section shows a good "mundic reef," side by side with a "buck reef." Such an experience may be accepted as a warning that, although a reef may happen to present at its outcrop nothing but "buck" stone, the whole reef is not necessarily of that character.

St. Patrick has proved one of the richest reefs in the field, and is distinguished by an unusual width of gangue.

Mexican reef not only cuts through the granite, but also intersects, nearly at right angles, a band of slate 3 to 4 ft. wide. The reef is sometimes as much as 15 ft. wide. The workings are now in the mundic at a depth of 250 ft., and are found to be richer than in the brownstone. A recent crushing gave 2 oz. 7 dwt. The gold is said to be finer in grain in the mundic than it was in the brownstone. The best stone is a dark mixture of quartz and slaty débris, the quartz containing specks of galena and some pyrites.

Rainbow reef runs about 20° W. of N., at the foot of the Towers Hill, and hades at 38° to E. 20° N. It has an engine-shaft 220 ft. deep, and is being vigorously worked. The walls are usually less than 4 ft. apart, and carry, on an average, 12 to 15 in. of quartz, generally whiter than is the rule on the field. The quartz veins contain good mundic. The mullock also contained mundic in the vicinity of the reef, but not good enough to crush. An E. and W. diorite dyke cuts the reef, but does not influence its bearing qualities.

North Australian reef has a course nearly parallel to that of the Rainbow, with an underlie of 47° to N.N.E., and penetrates both the syenite country of the Towers Hill and the granite country to the N.W. The reef varies from 1 to 4½ ft. in width. At the date of Jack's visit, the quartz vein in the reef was 8 in. wide. The mundic of this reef appears to be richer in galena than most of the others in the field. The last crushing (of 360 tons) gave 3 oz. to the ton. A perpendicular dyke of diorite, 5 ft. in width, running E. 15° S., cuts the reef, and is believed to favourably affect the auriferous character of the mundic. There was very good stone (3½ to 4 oz.) above the dyke at the 235-ft. level. Veins of gypsum occur on the sides of the dyke.

Newton Butler reef lies about 1½ mile S. of the Comstock, in granite country. It is still in the brownstone. The present owners have crushed as low as 18 dwt., and as high as 2½ oz. to the ton.

Warden reef district, on the N. of the Broughton, 5 miles from Charters Towers, has recently been opened up. Reef A is down 30 ft. in the brownstone. A trial crushing from the upper part of the shaft gave 4 oz. to the ton. A little carbonate of copper is visible in the brownstone. The reef averages 1 ft. wide. Reef B was just being opened up from the surface at the time of Jack's visit. It averages 2 ft. 6 in. wide, and contains a little pyrrhotite. As this mineral occurs in a fresher condition than is usual in the brownstone, it is possible that the weathering of this reef does not reach the customary depth, and that the brownstone may shortly be expected to give place to mundic.

Generalities.—The rich gold-field of Charters Towers occupies the W. edge of an area of granite and syenite, bordering on the little-altered slates and grits of the Sandy Creek district. It was discovered in 1872 by H. Mosman, C. E. Clarke, and J. Fraser, who left the Seventy-mile field to prospect the distant Towers. The first claim was laid off on the 25th March, 1872, and the district, including an area of 1700 sq. miles, was proclaimed a gold-field on 31st August of that year.

It is only when the reefs have been laid down on the map that it becomes apparent that they follow a definite system. They form a sort of horseshoe bend, with its convex side to the S., and underlie towards the centre of this curve at a low angle. At present, visible gold is a rarity in the reefs; but experience having shown what classes of stone yield most when crushed, the miner is in no way dispirited even if he never sees the "colour" in his workings. There is considerable monotony in the underground operations, which present the same country, the same gangue, and the same phenomena at and above the water-level.

It appears to be undeniable that in the Charters Towers gold-field, as in other auriferous-pyrites regions, it is to a certain extent true that the surface of a reef is sometimes exceptionally rich in gold. The region of "brownstone" (pyrrhotite and peroxide of iron) coincides with that superficial part of the rock which is not permanently saturated with water, and into which the atmosphere penetrates. A second region, that of "mundic" (auriferous sulphides), is co-extensive, so far as is yet known, with the zone of permanent saturation. The rainfall is understood to circulate "chiefly within a film of the rocky crust not much exceeding 2000 or 2500 ft." (Dr. Page). As, however, the lower limit of saturation must vary according to the compactness of the rock and the weight of the water, it may be accepted as certain that this is an overestimate for a district of small rainfalls and hard granite rocks. In the progress of denudation, the upper zone, which may be called the "zone of intermittent saturation," must necessarily invade the lower zone, that of "permanent saturation," while the lower limit of the latter will sink deeper and deeper into the crust of the earth.

The brownstone is mundic which has undergone oxidation, the pyrites being altered to pyrrhotite. As, however, there is no reason to doubt that the gold exists in the mundic stone, it seems difficult to account for its greater abundance in the superficial brownstone. The explanation is this:—On the denudation and oxidation of the upper portion of a reef, the gold mixed with the denuded sulphides is set free, and is carried with the aid of rains and by virtue of its own high specific gravity into the porous weathered upper part of the reef, which is next in turn to undergo denudation; and it may thus happen that the "capping" of a reef is enriched with loose gold. Add to this that the working of the surface is much easier than that of the deep levels, and it will be seen how, in many cases, only the upper part of a reef may be payable.

Gold disseminated through the granite rocks themselves is occasionally evident to the naked eye, but it may be present in many cases in quantities so small that neither the microscope nor ordinary analysis will detect it. That it has been collected in veins from the granite rocks, by means of lixiviation, is rendered very probable from the fact of the auriferous pyrites occurring in the "zone of permanent saturation." Arsenic is scarcely known in any form in the field.

A good deal of surfacing has been done on the field at one time or other. One party was engaged in December in stripping surface from the flat between the Moonstone and Welcome reefs. The surface on being tommed at Sandy Creek, about a mile distant, yielded 1 dwt. to the load.

The annexed table shows the progress of the gold-field, and its yield of gold :—

Year.	Stone crushed.	Yield of Gold from crushing.			Average of Gold per ton of Stone.			Tailings treated.	Yield of Gold from Tailings.			Gold escorted.		
	tons.	oz.	dwt.	gr.	oz.	dwt.	gr.	tons.	oz.	dwt.	gr.	oz.	dwt.	gr.
1872	12,054	20,063	19	5	1	14	5	..		..		31,287	2	5
1873	37,937	59,835	0	0	1	11	13	..		..		74,746	0	0
1874	33,097	52,872	14	21	1	11	23	..		..		62,345	0	0
1875	36,876	62,214	0	0	1	13	17	..		..		69,277	0	0
1876	37,500	58,068	2	10	1	10	23	1525	779	0	0	67,615	0	0
1877	36,030	66,479	3	16	1	16	22	2978	1799	14	0	87,200	14	20

Year.	Difference between yield of Gold from Crushing and amount escorted.			Number of Miners' Rights issued.	Number of Miners working Quartz.	Number of Miners working Alluvium.	Number of		Number of Steam Winding and Pumping Machines.	Number of Horse Whims.	Greatest depth of payable Gold.	Greatest depth of any vertical Shaft.
							Crushing Machines.	Heads of Stampers.				
	oz.	dwt.	gr.								ft.	ft.
1872	11,223	3	0	2303	2000	800	6	79	..	..	50	120
1873	14,911	0	0	2418	850	50	?	84	10	8	75	120
1874	9,472	5	3	1717	1200	50	?	94	8	6	150	150
1875	7,063	0	0	1359	1030	30	7	93	?	10	226	225
1876	9,546	17	14	1224	1140	130	9	104	20	26	250	230
1877	20,721	10	4	1286	1100	20	11	123	13	29	420	240

It appears from the above figures that (excepting the first year, 1872, which includes only a few months) the annual quantity of stone crushed, and the amount of gold produced have been practically the same, the last year (1877) showing the best return of gold since the opening of the field. Steady employment seems to have been afforded by the reefs for about 1100 men. So far, therefore, as experience goes, there is nothing to indicate a falling off in the production, or even (in spite of some exceptionally rich finds in the brownstone) any serious average difference between the yield of the mundic and brownstone. (For the first year or two, the workings were mostly in brownstone, and for the remaining years mostly in the mundic.) Taking into account the increased difficulty of extracting the gold from the mundic, the difference, if any, would appear to be rather in favour of the latter.

There is no reason to expect any material change in the nature of the reefs within the limits of the zone which the workings have now almost all reached, viz. that of "permanent saturation," unless it be, perhaps, an increase in the quantities of heavy metals or ores—gold, silver, sulphides of iron, and perhaps of copper. Whether the source of the gold, &c., in the reefs was the adjacent country, or whether the metals and ores were derived from below, the heavy precipitates from their solutions would tend to be deposited in the lower parts of the fissures more than in the higher. Jack does not mean to predict that every reef in the field will prove richer below than above, but the observation, he is firmly convinced, will be true of the field as a whole.

Admitting that granite rocks in a region of low rainfall may not be permanently saturated below 2000 ft., it will be seen from the table that the workings at Charters Towers have hardly yet reached more than a fifth of this depth. It must, therefore, be some time before the question of the continuance of the gold below the limit of "permanent saturation" can be put to the test.

It is true that the difficulty and cost of the workings must augment with the increasing depth, but, on the other hand, there is to be set against this the inevitable cheapening of materials, carriage, labour, and cost of living, which must follow the natural growth of population, as well as the gain from improvements in the method of treating pyritous tailings, and the utilization of the abundant lead-ore associated with the gold. Taking all these into account, it will probably be a very long time before the gold will not pay for working.

The horseshoe arrangement of the principal reefs has already been alluded to. An important group of the principal reefs in the field ought, if they continue in depth, to converge at some point within the horseshoe bend. The reef fissures, if protracted beneath the surface, would converge along a vertical line—the axis of elevation, centre of depression, or seismic vertical, according to the theory adopted for the cause of the fractures. This line may be expected to lie to the N. of Millchester, probably between the township and Mosman's Creek. The upper reefs may reach it at a depth of perhaps a mile. It is not to be expected that those reefs will ever be worked down to this depth, still less that the underlying and more distant reefs will be worked till they impinge upon the imaginary vertical line; but it may reasonably be expected that as they approach the centre of disturbance, they will prove richer in metallic deposits. The region between Millchester and Mosman's Creek, as being directly over the focus of disturbance, may also be pointed out, theoretically, as one where reefs may be expected to prove exceptionally numerous, and perhaps exceptionally rich. The force of an earthquake shock, and consequently the chance of fracturing the rocks, is, of course, greatest above the seismic vertical. The seismic vertical is also, of course, the shortest line from the focus to the earth's crust, and a fissure at or near it would have the best chance of receiving deposits from solutions brought up from below.

Thomas Buckland, assayer, has furnished some notes on the quality and value of the gold of Charters Towers and neighbouring fields. The best gold lies within a circle of 2 miles radius around Queenton, with the single exception of the Union Jack, where the best gold on the field has been obtained, value 3*l.* 15*s.* 6*d.* per oz. The Union Jack is surrounded by poor gold. Buckland's results are given in the annexed table:—

Reef.	Mint Value of gold.		Reef.	Mint Value of gold.	
	In Brownstone.	In Mundic.		In Brownstone.	In Mundic.
CHARTERS TOWERS, INSIDE REEFS.					
	£ s. d.	£ s. d.		£ s. d.	
St. Patrick	3 9 2	3 5 2	Rainbow	3 14 4	..
North Australian ..	3 13 1	3 10 0	,, ...	3 10 5	..
Just-in-Time	3 9 8	3 4 10	,, ...	3 11 0	..
Queen	3 9 11	3 7 0	,, ...	3 12 6	..
Papuan	3 8 7	3 5 7	General Wyndham	3 12 3	..
			,, ,,	3 13 10	..
CHARTERS TOWERS, OUTSIDE REEFS.					
Rose, Shamrock, & Thistle ..	2 16 11	..	Puzzler	3 0 6	..
			,, ...	2 19 10	..
,, ,,	2 15 10	..	Imperial	3 6 8	..
Southern Cross ..	2 19 2	..	,, ...	3 2 0	..
Stockholm	3 1 5	..	Old Warrior	3 0 5	..
Newton Butler ..	2 19 4	..	,, ...	3 5 11	..
,, ,, ..	3 0 3	..	Alexandra	3 6 8	..
,, ,, ..	3 1 3	..	,, ...	3 5 3	..
Merry Monarch (lowest) ..	3 1 8	..	Union Jack	3 15 6	..
REEFS AT A DISTANCE.					
Bluff (Alice P.C.) ..	3 2 0	..	Dreghorn	3 18 6	..
,, ,, ..	2 17 6	..	Rochfort	3 2 11	..
,, (Livingstone P.C.) ..	2 7 7	..	,, ...	3 1 10	..
,, ,, ..	2 17 6	..	Seventy-Mile (reef)	2 17 6	..
,, ,, ..	2 19 9	..	,, ,,	2 14 6	..
,, ,, ..	2 8 10	..	,, (Pyle's reef)	2 14 10	..
	Full Values.			Full Values.	
Seventy-Mile alluvial, heavy nuggety	3 13 4	..	Brook's alluvial, finer nuggety	3 13 0	..

The alloy is silver with a little iron. Alluvial gold contains 0·003 per cent. of iron, crushed gold 0·01 per cent., supposed to be derived from the stamps.

The best gold of the field, as will be seen by the table, compares unfavourably with the gold of Victoria and New South Wales. The quantity, however, atones for the deficiency in quality.

It is incredible that all the reefs on the field have been discovered, or estimated at their true value. Every miner knows that the best reefs present frequent blanks, or contain for a time only "buck" stone, and in the course of denudation these unpromising or irrecognizable portions of a reef may just as well occupy the surface as unmistakably auriferous mundic or brownstone. The field cannot be considered as thoroughly explored until a systematic course of tunnelling shall have been carried out in every direction, especially at right angles to the courses of reefs already known.

Gympie gold-field.—This gold-field is described in a report by A. C. Gregory on the geology of part of the districts of Wide Bay and Burnett, published in 1875.

Approaching the Gympie gold-field from the sea-coast, the principal geological feature of the country is the extensive development of the porphyritic rocks, which, rising through the Carboniferous strata, form the range dividing the valley of the Mary river from the Maroochydore river, and, extending in a S. direction, exhibit the remarkable outbursts known as the Glass House mountains. Descending from this porphyritic range into the valley of the upper Mary river, the Devonian slates appear on the surface; the stratification is apparently much disturbed, and the dip is generally at a high angle.

At Gympie, these slates include a thick bed of calcareous rock, containing numerous impressions of *Spirifera* and other Devonian fossils, and also layers of rounded pebbles of crystalline felspathic rock. These fossils and boulder-beds are interstratified with a hard dark-blue rock, having the external appearance of being of igneous origin; but the excess of carbonate of lime, and the fact that thin beds of the same rock are regularly interstratified with slates in other parts of the district, indicate that it is a sedimentary rock, and not a greenstone-trap as originally supposed.

The determination of the sedimentary character of this rock is of considerable importance, as it indicates that the auriferous reefs which traverse it are likely to preserve the same character to a very great depth; and that the working of the mines will only be limited in depth by the increased difficulties attendant on deep mining, or penetration to the siliceous slates which dip under the gold-field from the N.E.

The Devonian slates, in Queensland, where composed chiefly of silica, with little alumina, seldom contain metalliferous veins of any importance, and it is only where lime or magnesia is combined in considerable quantity that the quartz veins which traverse it present any notable mineral deposits; and it seems that the presence of the alkaline earths forms conditions which are specially favourable to the deposition of metals. The rocks in which the productive gold-reefs at Gympie are worked, belong to the series which contain a large proportion of lime; while the slates which dip below them from the N.E. are nearly devoid of lime and magnesia, and have not shown indications on the surface of any valuable mineral deposits; and it may be expected that, on penetrating through the calcareous rock, the reefs will cease to be productive as they enter the siliceous slates beneath. The great thickness and high angle of dip of the lime rocks would indicate that, except near their N.E.

margin, there is little prospect of the siliceous slates being within the scope of even deep mining; though it tends to the inference that the S. extensions of the known reefs are likely to afford the best field for deep mining.

The general strike of the rocks on the Gympie gold-field is N.W. and the dip S.W.; the auriferous veins or reefs average a little W. of N., but the band of greatest auriferous development is parallel to the strike, or N.W., crossing the various reefs diagonally, so that the productive portion of each is seldom of any great length; and they are sometimes cut off by slides in the rock, which dip N.E. and bear N.W. The N. sides of these slides seem to have been forced to the N.W., and consequently these fractures have remained closed, and contain little if any veinstone; while the fractures which have a N. bearing, or across the strike of the rock, have opened, and subsequently filled with quartz, calcspar, iron-pyrites, and gold. The fractures appear to have been very irregular, and large fragments of the side rock have fallen into them, so that the spaces subsequently filled by the veinstone are very irregular, and the deposited quartz and calcspar are sometimes so mixed with fragments of the side rocks that it is difficult to form any accurate estimate of the average thickness of the auriferous veins.

The quartz and calcspar contain much iron-pyrites, which also abounds in the side rock near the quartz veins; and although the gold is generally mixed with the pyrites, yet far the larger proportion is in separate and distinct pieces, and there is a tendency to form separate groups; but the manner in which the crystals of quartz, calcspar, and pyrites cut into each other, and are indented by the gold which is in other parts moulded to the angles of the crystals, shows that they were all deposited at the same period, while the lime taking the form of calcspar indicates that the deposition was at a low temperature.

Proceeding W. from Gympie, the Devonian slates extend for about 3 miles, but on ascending the range which forms the watershed between the Mary river and Glastonbury Creek, granite, with a cap of coarse sandstone, forms the higher hills; the slates form the lower ridges as far as Widgee Creek, the S.W. heads of which rise in the granite tableland on which the Black Snake gold-workings are situated. They and other adjacent gold-workings are on thin veins of quartz, which traverse the granite, and contain iron- and copper-pyrites with a little gold and silver.

The quartz and pyrites being much decomposed near the surface, when the reefs were first opened, there was a considerable quantity of free gold easily extracted by crushing and washing; but on sinking, the rock was not only harder, but the pyrites interfered with the crushing, by cutting the gold with its sharp angles, and at the same time it acted chemically on the mercury in the battery, forming a crust over which the smaller fragments of gold passed, and the production of the precious metal did not pay the expenses of working. Subsequently, attempts were made to extract the gold, silver, and copper from the pyrites, by collecting it below the crushing-machine and smelting in furnaces, which were erected on the spot at great expense; but the results do not appear to have been satisfactory, as the works are no longer in operation.

About 4 miles to the N. of the Black Snake table-land is the Kilkivan gold-field, situated on the E. side of a range of slate and serpentine hills, which trend N. and S. The alluvial gold was found at the foot of a remarkable mass of quartz rock, on the E. face of a hill of blue slate; the quartz consists of very fine grains, which, by their aggregation, form a compact white stone; there are, however, small cubic cavities with stains of oxide of iron, indicating that they have been occupied by pyrites, which has decomposed. Rolled fragments of this rock, with slate and serpentine, but little quartz, formed the alluvion, and the principal deposits of metal nearly follow the existing ravines now draining the country. Gold was also found in the earth filling the fissures of the quartz rock nearly to the summit of the hill, which is 700 ft. high; but, though several shafts and tunnels were cut into it, no gold was found in the rock itself.

About 1 mile to the N. of Kilkivan hill, a quartz vein, called the Rise and Shine, is being worked. The bearing is nearly N. and S.; dip, 80° to E.; thickness, 1 ft. The quartz contains iron-pyrites, galena, traces of copper, and gold. The rock is serpentine-slate; and the workings have reached a depth of 100 ft. The prospectors' claim, and those next N. and S., show some good specimens of gold; but as there has not been any large quantity crushed, it is difficult to form any estimate of the probable returns in the large way of working, as the gold is in very small grains, and so mixed with the pyrites that it is not easily distinguishable in the masses of quartz.

There are 3 small reefs parallel to the Rise and Shine on its E. side; the first consists of decomposed iron-pyrites; the second, calcspar, quartz, and pyrites; and the third, quartz and pyrites; but no gold was observed in them. A south continuation of these reefs would cross the slate hill which rises on the W. side of the quartz mass at Kilkivan; and it seems probable that the gold there resulted from the disintegration of a rich portion of the vein which was washed down the hill on its E. side. The alluvial workings have been abandoned, and only one shaft was in use, the wash-dirt appearing very poor.

Gold, but in very minute quantity, was found at the crossing of Bongmillerer Creek, about 8 miles N.E. of Kilkivan; but, in consequence of the heavy rain and flood, the bed of the creek could not be explored.

The rocks in this locality are slate and serpentine; and it is possible that some part of the channel might be worked in dry seasons to advantage. Gold has been frequently found in the gravel of the creeks, and pieces of several grains' weight have been discovered in a quartz vein near the Normanby copper-mine.

Marengo.—This gold-field was described by Robert L. Jack, in a report dated May 15, 1879. It occurs between Selina Creek and Boundary Creek, tributaries of the Don river. It lies S. 32° W. from Bowen, the direct distance being 23 miles, and by the road up the Don valley about 25 miles.

In this region, a low table-land spur of the Clarke range projecting N. divides the head-waters of the Bogie from the parallel valley of the Don. The lithology of this limited area may be described as essentially a white granite,. in which the mica is sometimes supplemented and replaced by hornblende, with frequent bosses of intrusive pale-pinkish felspar-porphyry (the felspar highly acidic), and occasional small patches of gneiss and mica-schist, and of still-recognizable shales and greywackes. Most of the spurs in which the reefs occur drain N. into Marengo Creek, which joins Selina Creek near Marievale.

Marengo was opened up about 1871, but cannot be said to have flourished at any time. The claims as a rule were taken up by working miners, who found it impossible to repay themselves for their outlay in time and money without the intervention of a capitalist. The place, therefore, died a natural death before the completion of the initial stages of the work, when "backing" is indispensable. Whether with backing, the field might have paid, is a question to be discussed after the reefs have been individually described.

Seymour's reef is on a ridge on the left bank of a gully which falls into Marengo Creek above Toomey's camp. It runs W. 11° N., and underlies to N. 11° E. The country is hornblendic gneiss, mica-schist, and slate, with a N. and S. strike. The reef was opened in 1877, and gave 3 oz. of gold from a patch in a short drive into the hill, by hammering the quartz on a stone; from another drive, 20 ft. lower, 8 oz. was got by crushing in a machine; and from a shaft sunk 36 ft. on the underlie, 2 tons of stone when crushed yielded 1 oz. 11½ dwt. of gold to the ton.

The reef occurs in bulges from a few inches to 1 ft. wide. It is a cavernous quartz, with long thin crystals (hexagonal prisms). Crystals of copper-pyrites are frequently imbedded in the quartz crystals, and the spaces between the quartz crystals are filled up with decomposed pyrites (brownstone) and yellow ochre. Joint surfaces are frequently coated with carbonate of copper. The reef adheres to the lower wall of a 2-ft. dyke of syenite. In Seymour's upper drift, a vein of hard white granite, 4 to 8 in. wide, follows the line of strike of the slates (N. and S.), and pierces the syenite dyke, but stops short on the upper side of the reef.

About 200 yd. down the gully, Toomey and a few others have recently been sluicing. They got some coarse gold (largest nugget about 5 dwt.) pretty equally distributed throughout 2 ft. of red sandy and clayey half-consolidated gravel, above a rocky bar. The surface of the rock (the bottom) is channelled into potholes, 6 ft. deep and upwards, often full of large stones. The gold is very little rounded. It has a ragged scraggy appearance indicative of a large proportion of silver, and has cavities coloured brown from the decomposition of the formerly adherent iron-pyrites.

Some 200 yd. up the gully on the left bank, the outcrop of the Venture reef is visible. It is here white cavernous quartz with small hexagonal crystals. It runs W. 31° N., and underlies at a high angle to N.E. Toomey got 6 dwt. of gold in the gully about 100 yd. below this. He also sunk a few feet on the reef near the gully, and got a little gold. The reef is only 8 in. wide at that place, with, however, a promising stone; it is traceable across a ridge and gully to the W. On the left bank of this gully, 2 shafts were sunk on the reef to the depth of 65 ft. Toomey made two crushings of the surface stone with his own small battery, the first giving 15 dwt., and the second (7 or 8 tons), 8½ dwt. of gold to the ton. The next lot (40 tons) was of mixed brownstone and mundic, from the lower levels, and was crushed at machine for 3½ dwt. to the ton; 18 tons from a higher level gave 12½ dwt. to the ton.

In the brownstone of the foot-wall, a red leader with kernels of blue carbonate of copper carried the gold conspicuously well. Some specimens are visible of quartz mixed with brown decomposed pyrites and green carbonate of copper. This also carried some gold. At the 65-ft. level, the brownstone was replaced by undecomposed iron-pyrites, with some copper-pyrites. A little water was coming in from the foot-wall. The walls are said to have been well defined at the lower level, the average width of the reef being about 3 ft., with mundic mixed throughout. A "horse" of the country came into the reef at the mundic level, but seemed to be dying out in a drive to the W. A parcel of mundic (very pale iron-pyrites in minute cubes), picked clean from quartz, and assayed, was reported to contain 1 oz. 6 dwt. 3 gr. of gold and 6 oz. 12 dwt. of silver to the ton.

About 150 yd. S. of the Venture, another reef crosses the ridge on which Seymour's mine is situated. The reef runs W. 11° N. and dips to N. 11° E. at a very high angle. Sometimes the reef is only represented by a 1-in. vein of reddish quartz. Where the reef bulges out, sometimes to 2 ft. in width, the reddish vein keeps the foot-wall. At the opening of Marengo, Toomey and others "dollied" a little of the red vein, and obtained about 6 dwt. of gold to the ton.

On the left bank of the gully to the W. of the Venture, is another reef running W. 4° S., and dipping slightly N. A shaft 10 or 12 ft. deep was sunk on the reef at the opening of the field, and fair prospects were obtained by hand-crushing. The quartz has a good deal of brownstone.

Some 20 yd. S. of this is another shaft sunk for 50 ft. on the underlie of a reef running W. 6° N., and hading N. 6° E. The reef is 8 or 9 in. wide, with a red leader on the hanging-wall. Some of the stone is coated with yellow ochre, and contains brownstone and a little copper-pyrites.

About ¼ mile W. of the last-named workings, on the crown of a low ridge, is the Caledonian reef. It runs W. 1° N. and dips to N. 1° E. at 55°. The reef was worked about 1871. It is a mass of parallel quartz veins about 3 in. thick, with mullock (gangue) between. The quartz shows a moderate amount of green carbonate of copper, besides brownstone. The whole of the stone taken out was crushed, and gave 16 dwt. to the ton. One shaft was sunk 20 ft. vertical and 40 ft. on the underlie.

At a point on the W. side of the Marengo and Pretty Bend road, bearing W. 40° S. from the West Brother, and W. 38° S. from the Mid Brother, is a group of reefs. *A* is a large reef of white quartz, with joints stained with peroxide of iron. *B* is about 10 to 20 in. wide, underlies at 60° to N., and has cavities well filled with brownstone. *C* is a vein of 1 or 2 in. traversing granite, or, more strictly speaking, a joint in the granite faced with small dog-tooth quartz crystals. Toomey got colours in *B*, but none in *A*. McDivott got specimens (quartz showing free gold) in *C*; one stone weighing 15 lb., containing 14 oz. of gold. He washed 200 oz. of gold from 2 ft. of surface on the top of the hill about 4 years ago. Toomey afterwards got 100 oz. from the same place, and 4 oz. down the slope from reef *C*. Very little gold was got in the gully below *C*; but a good deal in the creek into which the gully empties itself. Down the hill along the line of the reefs *B* and *C* to their junction, the gold obtained from the surface was loose "reef-gold," very open and porous, and quite unworn. Below the junction of the reefs, "specimens" only were obtained—pinkish-white rubble from the larger reef, specked with visible gold. From the position of the auriferous surface on the top of the hill, as well as from the unworn character of the gold, it is evident that the surface here was not washed from any distance, but resulted from the decomposition, on the spot, of the granite and the reef.

Manchester reef lies on the top of a ridge at a point W. 34° S. from the West Brother, and W. 12° S. from the Mid Brother. It runs E. 6° S.

and dips to N. 6° E. at 50°. It was worked about 8 years ago in an opencast 50 or 60 ft. in length, and a vertical shaft reaching the reef at 40 ft. in depth. In the opencast, the reef was 5 ft. wide in places and very white. At a greater depth, it averaged 18 in. The cap stone only crushed 12 dwt. to the ton, the next 16 dwt., and the lowest 18 dwt. A heap of about 2 tons of picked brownstone lying at the surface looks very good. The country is tourmaline-porphyry, with a band of chlorite-slate underlying the reef. The quartz near the foot-wall and the foot-wall itself are a good deal stained with carbonate of copper, of which the slate also contains some specks. The reef is traceable for nearly ½ mile down the ridges to the W. At the end of the ½ mile, a small opening was made in the reef (simultaneously with the Manchester workings), but no crushings were taken out. The quartz is a good deal stained with carbonate of copper. Some specimens of selenite stained green with carbonate of copper are also obtainable. This spot was marked out for a copper selection, as was the whole distance from here to the One-mile Mountain (about 2 miles). The proportion of the copper is, however, much too poor to pay for extraction.

James Frankie reef occurs on the top of a ridge at a point bearing W. 15° N. from the Mid Brother, W. 1° N. from the West Brother, and E. 41° S. from the One-mile Mountain. Its course is W. 41° N. It is vertical or nearly so. The country is grey granite, impregnated with carbonate of copper near the walls. The reef is quartz, varying from nothing up to 9 in. wide. It occupies the centre of a course of greywacke about 2 ft. wide. The quartz is intersected by horizontal joints, and has vertical cavities parallel to the sides of the reef, lined with small crystals, the interstices being filled up with decomposed pyrites. Dipple worked the upper part of the reef (opencast); he crushed 14 tons, at the rate of 12 dwt. to the ton. Toomey and others worked a lower level (15 ft.), from which they took 5 tons, which gave them 7½ dwt. to the ton.

Toomey's reef is on the top of the same ridge as the James Frankie. The place bears W. 1° S. from the West Brother, and E. 44° S. from the One-mile Mountain. Its course is E. 8° S., and its underlie 65° to N. 8° E. The reef was opened up in 1878 by Toomey, who sunk a shaft 50 ft. down the underlie. It varies from 1 to 18 in., and has a good deal of brownstone, derived from large crystals of pyrites, whose form is still recognizable. Quartz crystals, coated with crystals of specular iron, are common. The country is grey granite, specked near the reef with fine pyrites. The walls are stained with carbonate of copper. To the W. of the shaft, the reef splits up into two; 10 tons gave 1 oz. 2 dwt., and 2 tons, 1 oz. 1 dwt. to the ton.

Albion reef lies due W. of the Mid Brother and S. 20° W. of the One-mile Mountain (which is about ¼ mile distant across the valley).

The reef is vertical, and occurs on the crown of a ridge. Its course is W. 19° N. The reef, where it has been left, is about 10 in. wide, and consists of a white quartz with ferruginous cavities. From a shaft about 50 ft. deep, some quartz-stained or joint-planes, with carbonate of copper, has been brought up. It is not richer in copper than several other reefs on the field, but it was taken up for copper at the opening of Marengo, and all the country between this and the Manchester was pegged off for copper selections. Only 2 cwt. of copper-ore were sent down, and are said to have yielded 11 per cent. of copper, besides gold at the rate of ½ oz. to the ton. Toomey crushed 1 ton from the bottom level, which yielded 16 dwt. of gold. The country is grey granite.

One-mile Mountain consists of coarse white granite ; several reefs re visible all round it, some with very good-looking brownstone. One on the tongue connecting the mountain with the table-land behind, ru N. 6° E., and hades to E. 6° N. A little opencast work has been done on it, and about 6 tons of stone are lying at grass. About ½ mile W. of the One-mile Mountain is a huge blow of white quartz. The reef must be at least 20 ft. in thickness. It runs W. 21° N., and hades N.E. at an angle less than 45°. A few holes have been sunk on it, and some brownish stone has been taken out. Some specks of decomposed pyrites are seen.

A few holes have been made on a reef N. of Bode's old killing-yard. The reef runs N. 6° E. Some fair brownstone lies at the surface.

The alluvial gold found in the Marengo gullies has a very scraggy or ragged appearance, betokening a large amount of silver alloy ; is pitted with red cavities, due to the decomposition of the pyrites with which it was originally associated in the reefs ; and is very little rolled. Gold of this character is usually found only in the neighbourhood of the reefs, the finer particles, which form the bulk of the gold in the reefs, having been, as at Normanby, disseminated too widely to be ever collected in payable quantities. Alluvial gold found on the top of the table-land is said to be more water-worn, and in good "shotty" nuggets. Payable patches of gold are few and far between, both on the table-land and the underlying spurs.

Whether they will pay is the great practical question regarding the gold-fields just described. Any part of the Coast Range in which a group of reefs occurs is a gold-field in the same sense that Marengo is. A limited amount of gold is present in the reefs, associated with pyrites and (above the water-level) with decomposed pyrites. The proportion is too low to cover the expenses of working, while wages, rations, and appliances remain at or near their present rates. The situation of Marengo is about as favourable as could well be hoped for, with a good road to a port within 25 miles, and machinery on the spot. When the conditions approach more nearly to those which obtain on some of the Victorian gold-fields—a large population steadily employed in alternate reefing and lead-work, economical living, and machinery in constant employment—Marengo, and a dozen similar localities, will undoubtedly pay. The Marengo reefs are so closely grouped that a single set of first-class machinery would be sufficient for the wants of the whole district. One or two of the reefs are almost good enough to pay even now, but could not bear alone the whole of the expenses necessary to put the field in going order. A gold-field in its infancy offers an exception to the usual laws of trade. The mines must bear in common the expenses of the machinery, &c., without which they are themselves worthless. Instead, therefore, of there being a struggle for existence, each individual miner is directly interested in the prosperity of his neighbour.

Normanby.—Robert L. Jack's report (May 15, 1879) on the Normanby gold-field may be summarized as follows:—

The Normanby gold-field lies 41 miles due S. of Bowen. It is reached by a road which follows the valley of the Don to its source, a distance of 48 miles, and then crosses the heads of the Dart [Emu], a tributary of the Broken river, for about 3 miles farther.

The Clarke Table-land consists almost entirely of metamorphic rocks. That these have undergone metamorphism, followed by extensive denudation, prior to Carboniferous times, is proved by the relations they bear to the coal measures of Pelican Creek and the Bowen river. There is much probability in favour of a pre-Devonian metamorphism. Here and there, as in Jack's and Flagstone creeks, shales, slates, quartzites, greywackes, Lydian-stone, and mica- and hornblende-schists are met with, having a still recognizable stratification, and there is little doubt that the whole range was originally composed of stratified rocks of similar character. In the immediate neighbourhood of Normanby, however, the occurrence of stratified rocks is notably rare. The N. edge of the table-land, including Mount Roundback, the Round Hill, and the Mamelon, consists of a well-marked white granite, occasionally passing into a syenite, the mica being either wholly or partially replaced by hornblende. Similar granite breaks out in isolated "tors" and cliffs on the N.E. side of the Normanby range. The Grant range is also for the most part granite. The Normanby range, on the other hand, consists almost entirely of tourmaline-porphyry, a ternary compound of quartz (for the most part amorphous), black mica (sparsely), and large or small crystals of black tourmaline (schorl). The whole rock is mixed up with minute crystals and streaks of iron-pyrites, and streaks and veins of serpentine. Occasional specimens may be found showing a passage from greywacke to the rock just described.

The Normanby gold-field was discovered, about 1872, by Sam Verge (better known as Long Jim), a stockman at Havilah, when camping out in search of wild cattle. He got "colours" in Green Creek, about 3 miles above its junction with the Dart. Following up these indications, he first lighted on Hibernia reef, from which he got some gold in white quartz at the surface, and took up a prospecting claim. The Marquis, Welcome, Star of Hope, Albion, Grace Darling, and other reefs were taken up almost immediately after, and for about 18 months the place bore the aspect of a flourishing reefing district.

The principal reefs lie along a line running S. 44½° E. across the heads of the gullies draining the S.W. side of the Normanby range. A less important parallel line of reef intersects Hungry Gully and Green Creek near their junction, striking towards Oakey Creek on the N.W. The reefs on both lines invariably underlie to the N.E.

Hibernia reef occurs on the ridge between the gully of the same name and New Zealand Gully. Its course is N. 17° W.; underlie, E. 17° N. at an angle of 75°. The prospectors worked the claim for about a year. As already mentioned, free gold was found in the quartz at the surface; ½ ton of stone was sent down to Sydney a few months after the opening of the reef, and gave a return at the rate of 4 oz. to the ton. An underlie shaft was sunk on the top of the ridge, and was met by a drive a few feet above the level of Hibernia Gully. The drive has now fallen in. John Smith, who visited it after the prospectors abandoned the mine, found the reef to be about 6 in. wide, and obtained a few colours from it. The prospectors had only one crushing, which yielded gold at the rate of 1 oz. 5 dwt. to the ton. The 6-in. vein which carried the gold is a crystalline quartz with interlacing dog-tooth crystals, the interstices being filled up with brownstone (decomposed pyrites) and occasional specks of copper-pyrites, less decomposed. A vertical shaft was sunk a few feet to the dip, but was abandoned at a depth of 10 or 12 ft. without having cut the reef.

About 130 yd. S.E. of the underlie shaft of the Hibernia, 3 shallow shafts have been sunk on the left bank of one of the heads of New Zealand Gully. The uppermost (S.E.most) shaft has struck no reef; the country is fine-grained tourmaline-porphyry. The second has followed a trifling leader for a few feet. The third cuts, at a vertical depth of 15 ft., a 2-in. leader of white quartz, containing a little pyrites. The leader has a N.W. course, and dips N.E. at 65°. The country is greywacke. The same leader is seen in a trench in the gully, where it has widened to 15 in.—a very white, vitreous, poor-looking quartz. Some 70 yd. S. of the last-mentioned leader, a small opening has been made on a leader of white quartz, 1 to 5 in. wide. Its course is E. 6° S., with an underlie at 85° to S. 6° W. An underlie in this direction is rare in the neighbourhood of Normanby.

Marquis reef crosses the crown of the ridge S. of the head of New Zealand Gully. It has a N.W. and S.E. course, and underlies to N.E. at about 40°. The reef was taken up by the prospectors within a few months of the opening of the Hibernia. They began work at a shaft near the W. corner of their claim, which they sunk on the underlie for a distance of about 90 ft. They had two crushings of brown honeycombed quartz, which gave 2 oz. and a few dwt. to the ton at machine. They left the white quartz untouched. In another shaft to N.W., the prospectors struck the reef at a depth of 16 ft., and followed it on the underlie to the level of the workings in the first shaft. They also sank about 12 ft. on the underlie down the hill to S.E. After being worked for about 18 months, the claim was abandoned by the prospectors. Having lain idle for some time, it was taken up by Duffey and others. This party sank a vertical shaft 71 ft. deep, on the dip side of the prospectors' first shaft, and struck the reef at the depth of 60 ft. They took out 9 tons of brownstone, which were crushed at machine and gave 2½ oz. to the ton. In spite of this encouraging crushing, the claim was again abandoned in September 1874, owing to the removal of the machine from the field, and the opening of Happy Valley diggings. When the claim was for the second time abandoned, the water-level had been reached in the bottom of the vertical shaft, and the brownstone had begun to give place to undecomposed pyrites.

In the hope of getting brownstone similar to that obtained by Duffey's party, an extended claim was taken up by the Venture Co., about May 1877. They sank a shaft on the slope of the ridge, 58 ft. S.E. of Duffey's shaft, and struck the reef at a vertical depth of 45 ft. They then drove 15 ft. up the underlie, and broke into the old workings of the prospectors. They next drove from the bottom of their shaft to the bottom of Duffey's. The reef was found to vary from 6 in. to 2 ft. in width, with not very distinct walls, except at the bottom of the company's shaft, where the foot-wall was hard and smooth ; brownstone was obtained in patches, although the quartz was mostly white. The company having brought their 4-stamp machine from the Grant valley, and erected it at the junction of New Zealand Gully and Marquis Creek, crushed 40 tons of brownstone, which gave 14 dwt. of gold to the ton. At the bottom of the company's vertical shaft, the water became too heavy for hand-baling, and the mundic was coming in. In the heap left at the surface is a good deal of copper-pyrites and some stains of carbonate of copper. The company also sank a shaft on the underlie side of the prospectors' S.E.most shaft. This shaft cut the reef at the depth of 20 ft., and followed the underlie for 6 ft. The reef was here 12 in. wide—a poor, dull, white stone, from which even "colours" were not obtainable. Three shafts have been sunk about 100 ft. to the N.W. of Duffey's vertical shaft, to catch the Marquis reef, but without success. The N.E.most shaft has, however, cut a leader of quartz about 3 in. wide—poor, dull, white stone.

New Zealand reef occurs to the S.E. of the Marquis, on a ridge between two of the heads of Marquis Creek. Its course is about 6° S. of E. It underlies to N., but at a very low angle, its outcrop following the contour of the ridge. It has a large "blow" at the surface, and was worked extensively in an opencast. Much of the outcrop is, therefore, still visible. Up the hill (to W.) is a long opencast working, from which the reef has been almost all taken out. Judging, however, by the remaining parts of the walls, it seems to have been 3 or 4 ft. in width. Numerous leaders enter the reef from the S. (foot-) wall—a circumstance which renders the existence of an underlying reef more than probable. A crushing of 90 tons from this working gave 2 oz. of gold to the ton. The country is decomposed greywacke. In the W.most shaft in the prospecting claim (on the top of the ridge) the reef was cut at a vertical depth of 10 ft., and followed on the underlie for about 60 ft. At this depth, the reef got narrower, and became a white "buck" with but little brownstone. A crushing from this shaft only yielded 1 oz. to the ton. A drive was made from the bottom of the vertical shaft for 10 ft. to the W., and for a much longer distance to the E., and from this level a great part of the first crushing was taken. The reef at the W. end of the drive is about 1 ft. wide.

In a shaft, 70 ft. deep, sunk on the underlie side of the E. end of the opencast working, the reef was not reached; at least only a 6-in. reef or leader was found. But, as the reef was found to thin away so much in the bottom of the deep underlie shaft, it is quite possible that the leader in the 70-ft. shaft really was the reef. The quartz at the mouth of the shaft is dull-white, with large crystals in cavities, their surfaces coloured bright-yellow. Very small "nests" of brownstone occur in the quartz, as well as a little carbonate of copper. Among the large quartz crystals, cubes of brownstone occur, still retaining perfectly the crystalline form of the original pyrites. The decomposed pyrites crystals are clustered on the faces of the quartz crystals, but never indent them, and appear therefore to have been formed after the consolidation of the quartz. The workings of the prospectors commenced a short time after the Marquis was taken up. When the Venture Co. abandoned the Marquis, they sank a vertical shaft, 12 ft. deep, in the gully, on the outcrop of the New Zealand (E. of the opencast workings), but found the reef pinching out.

The prospectors found a leader in the same line on the opposite side of the gully from their workings; but, as the rise of the surface on that side should carry the outcrop of the reef a good way to the S., Jack doubts if they were correct in supposing this leader to represent the New Zealand. The Venture Co. trenched about 30 ft. up the slope on this side of the gully, and discovered a reef of very white stone (no colours) about 1 ft. in thickness. Jack is inclined to think that this was the real New Zealand reef. It occurs, at any rate, where the reef might be expected to be met with, and the stone is very similar in character. The country of the New Zealand is greywacke and tourmaline-porphyry, specked with pyrites. One small specimen was picked up of half-metamorphosed greywacke, traversed by a vein of chalybite (carbonate of iron). The broken-up country (mullock or gangue), between the walls of the reef, is frequently impregnated with carbonate of copper. A shaft was sunk W. of the prospecting claim to a depth of 30 ft., in a line with the opencast workings. But, as the curve caused by the fall of the ground was not taken into account, the attempt to reach the reef was fruitless. In a shaft N. of the one last mentioned, a small quartz leader was found at the depth of 20 ft. The leader underlies to E.S.E., and is probably the representative of the New Zealand, although no gold was obtained from it. The country is tourmaline-porphyry, with a little greywacke. A shaft, 20 ft. deep, between the last-mentioned shaft and the Marquis (in greywacke country, with a little tourmaline-porphyry), has struck a 3-in. vein of very poor-looking, vitreous, bluish-white quartz.

Dillon's reef lies S.E. of the New Zealand, on the next branch of the Marquis Creek. Its course is S. 36° E.; underlie, E. 36° N. The reef is 2 ft. wide and upwards. It is a very white quartz, but is highly crystalline in the central parts, the cavities being filled with brownstone. On the right bank of the gully, the reef is very flat, except in the deepest shaft (30 ft.), where it pitches more steeply. On the left bank, the underlie is much greater, about 75°. Three crushings were taken from this reef, the first realizing 1 oz. 5 dwt., and the second and third, 17 dwt., of gold to the ton.

Star of Hope reef was taken up about the same time as the Marquis, and worked by the prospectors till the removal of the machine (about 18 months). It bears S. 35° E., and underlies to E. 35° N. The workings in the prospecting claim consist of two shafts on the crown of the ridge (the N.W.most in the claim), an opencast 20 ft. in length along the cap of the reef on the slope of the hill, a shaft 40 ft. vertical on the underlie side with a drive back to cut the reef, and a drive into the hill at the level of the gully (one of the heads of Garibaldi's Creek). Besides the above, two small shafts were sunk to the underlie, but failed to reach the reef. A little free gold was obtained from white quartz on the cap of the reef. The quartz is generally white, with occasional large crystals, now and then showing patches of decomposed pyrites. Joints and cavities are sometimes coated with green carbonate of copper. The country is fine-grained tourmaline-porphyry, but some fine-grained hornblendic greywacke, veined with serpentine, has been brought up from the 40-ft. shaft on the underlie side of the reef. The country in the neighbourhood of the reef is specked with pyrites. The prospectors had two crushings, which yielded about 1½ oz. of gold to the ton.

On No. 1 Claim N., on the N.W. side of the hill from the prospecting claim, very little has been done, and it is believed never to have had a crushing. The workings consist of three shallow shafts and an opencast. A small heap of fair crystalline quartz lies at the surface.

No. 1 Claim S. (S.E. of prospecting claim) was worked opencast over the whole length. The underlie was about 45° at the surface, but, at the depth of 20 ft., the reef pitched at a much higher angle. The brownstone gave out where the steep underlie commenced, and the reef became very white and barren. Water and mundic came in shortly after the steep underlie. The reef appears to have been here about 2 ft. wide, judging from some of the blocks at the surface. Some of the quartz in the heap lying at the surface contains a little pyrites, with which the country (fine-grained hornblendic greywacke and tourmaline-porphyry) is also specked. The pyrites in the reef is very similar in character to that of the Welcome, to be afterwards described. A shaft at a distance of 15 ft. from the outcrop reached the reef at a depth of 20 ft. Another shaft, farther to the dip, did not reach the reef, being abandoned (at 15 ft.) owing to the results of the second crushing (from a deeper part of the reef). A third shallow shaft, still farther to the dip, did not, of course, reach the reef, which must there be at a considerable depth. The first crushing (70 tons) of brownstone from the surface of the reef gave 3 oz. 7 dwt. of gold to the ton. The second and last, from the deeper workings, gave only a little over 1 oz. to the ton. The claim was abandoned after this crushing. It is believed that the owners took out the greater part of the payable brownstone within the limits of their claim.

No. 2 Claim S. lies S.E. of No. 1 S. The continuation of the reef was never found, although 5 shafts were sunk for the purpose—one to a depth of 50 ft. The explanation is, that in 4 of the shafts the reef lay at a greater depth than that to which the sinking was carried, while the fifth was sunk below the outcrop. The country is similar to that of No. 1 S. and is copiously specked with pyrites.

For the next 500 yd. along the line to the S.E., the reef was never found, although the two ridges (site of the Sharkeytown camp) were diligently searched by trenching in all directions.

Welcome reef runs E. 44° S. and underlies to N. 44° E. at about 70°. The prospecting claim was taken up by Hugh Clerkin and others about

6 months after the Marquis, and was abandoned prior to December 1874. The N.W.most shaft is 15 to 18 ft. in vertical depth, and follows the underlie for 70 ft. farther. The reef was also taken out between the bottom of the vertical shaft and the surface. At 45 ft. down the underlie from the bottom of the vertical shaft, water (not very heavy) and mundic were met with. A drive to the S.E. connected the workings of this shaft, at the 50-ft. level, with two other shafts. The country is a dark, fine-grained tourmaline-porphyry, poor in quartz, with pale iron-pyrites scattered throughout. The prospectors sank a second shaft 50 ft. N.W. of the first. It cut the reef at the depth of 40 ft., and followed it up to daylight and down the underlie. The shaft was also connected by the above-mentioned drive with the shafts to right and left. The mundic level was reached in the underlie workings. The country in the shaft is a fine-grained, cream-grey, syenitic granite, with cream-coloured felspar, quartz, hornblende, and minute scales of thin white mica. The prospectors' N.W.most shaft is 41 ft. N.W. of No. 2, in fine-grained, somewhat crystalline, hornblendic greywacke. It cut the reef at a vertical depth of 50 ft., followed it down the underlie, and was connected by the drive with the other two shafts. There is said to have been a 2-ft. mundic reef in the underlie. Two crushings of brownstone realized about 2 oz. of gold to the ton; ½ ton of the white mundic stone, stamped and roasted, gave 2 oz. of gold (4 oz. to the ton). Some of the stone was sent to Ravenswood, where it gave a result variously stated at 5 to 7 oz. to the ton.

The Venture Co. took up (in December 1877) an extended claim (3600 ft. along reef by 400 ft.). They sank a shaft, 45 ft. to the dip of the N.W.most shaft of the prospectors, to a vertical depth of 30 ft., at which depth they stopped short of the reef. The country is similar to that in the S.E. shaft of the prospecting claim. They raised 1½ ton of mundic from the bottom of the prospectors' N.W. shaft, where they found a mundic reef varying from 9 to 20 in. Having been beaten off by a suffocating and poisonous air, in which a candle would not burn, evidently carbonic acid gas accumulated owing to want of ventilation, they made up 2 tons by taking ½ ton from the old heap left by the prospectors; this, crushed by machine at New Zealand Gully, yielded 22 dwt. of gold to the ton. The tailings, on being roasted and amalgamated, gave gold at the rate of 5 oz. to the ton. The gold from the tailings was sent to the Sydney Mint, and pronounced only worth 37*s.* per oz. On receipt of this return, the sinking of the straight shaft was stopped, and the claim abandoned. The company, exhausted by unprofitable work at the Venture reef, "dead" work at the Marquis, and prospecting at the New Zealand, gave up the struggle, and thus ended the last reefing done at Normanby.

The mundic heap now lying at the surface (about 5 tons) is, of course, all of the prospectors' raising, and has probably been picked again and again for the best specimens. The mundic is mostly in minute crystals, and occurs in white uncrystallized quartz. It is a mixture of very pale iron-pyrites and yellower copper-pyrites. Occasionally a little green carbonate of copper is mixed up with the copper-pyrites. A specimen of the mundic assayed by Thos. Buckland, Charters Towers, gave a gold return of 8 oz. 9 dwt. 20 gr. to the ton, and a silver return of 1 oz. 12 dwt. 6 gr. to the ton. The specimen was pure pyrites, picked free from quartz.

No. 1 Claim N. (to the N.W. of the prospecting claim) was taken up while the prospectors were still working. Two shafts were sunk to the depth of 20 ft., but without coming on the reef. Taking the fall of the ground into account, it is probable that both shafts were sunk below the outcrop of the reef. The country is dark-grey tourmaline-schist and fine-grained hornblendic greywacke (frequent junctions seen). The rock is specked throughout with pyrites, and is fresher than usual on the field.

On No. 1 Claim S. (S.E. of prospecting claim), 2 shafts were sunk, neither of which seems to have reached the reef. A little quartz at the surface has probably come from small leaders. One specimen shows pyrites far gone in decomposition towards brownstone. The country is similar to that in the S.E. shaft of the prospecting claim.

In No. 2 Claim S., the N.W. shaft caught a reef or leader, and followed it down the underlie; this was probably a leader parallel to, and above, the Welcome reef. What little is left of it is of white barren-looking quartz, with only a few specks of brownstone, and seems mostly to have come from a vein not more than 2 in. wide, as evidenced by the slickensided faces on each fragment. The country is similar to that of the S.E. shaft of the prospecting claim; but there is also mixed up with it some amygdaloidal porphyry, probably from a dyke. The mid shaft is of no depth, and has not caught the reef. The country is the same as in the N.W. shaft. The S.E. shaft appears to have been sunk on a cross leader bearing N.E. and S.W. A little quartz has been got from a 2-in. leader with crystalline cavities in the middle. Sometimes a little brownstone occurs in the casing. The country is mixed tourmaline-porphyry and serpentine. No stone was crushed from No. 2 claim. All attempts to find the Welcome reef to the S.E. have proved fruitless.

On the ridge N.W. of the Hibernia is a vertical shaft, about 25 ft. deep. It then follows for some distance the underlie of a quartz vein about 5 in. in width, well slickensided on both sides. The stone has a particularly "hungry" appearance—dull-white and uncrystallized, with scarcely a trace of brownstone. The underlie is N.E.; country, greywacke. On the left bank of the next gully (a branch of Hibernia Gully), 2 shafts have been sunk, one vertical, the other from the surface down the underlie (45°) of a 9-in. reef of white quartz, with interlacing crystals in the middle. There is but little brownstone. The amount of work done has evidently been trifling. Country, greywacke. On the S.E. slope of the next ridge are 2 little shafts. In the lower, at the depth of about 12 ft., a very white quartz vein, poor in brownstone, has been cut. The shaft appears to have been abandoned at once, owing to the unpromising character of the stone. Some specimens of the stone are veined with chalybite. In the upper shaft, at the depth of about 20 ft., a 4-in. leader is cut, and followed for a few feet. The quartz is white, and looks peculiarly unpromising. The country is fine-grained tourmaline-porphyry.

On the N.W. side of the same ridge is a group of trial workings, consisting of 2 openings on a leader of 8 in., heading to the N.E. at 45°, and a vertical shaft about 15 ft. deep. The latter shaft has probably cut the same leader. The stone brought up (very little) is white and barren-looking. Farther down the slope of the same ridge are 2 shafts. One appears to have caught (at 12 ft.) a joint in the rock, possibly representing the Glengarry reef, for which it was doubtless sunk. The prospectors seem to have been disappointed in this, as no quartz has been raised. The country is shivery, much-jointed greywacke. The other shaft (to N.E.) is only 8 ft. deep, and has caught no reef. The country is dark-grey, coarse-grained tourmaline-porphyry, the tourmaline crystals being occasionally grouped together in black shining masses.

Glengarry reef occurs on the side of the hill, below the two last-mentioned reefs. It bears W. 15° N., and underlies to N. 15° E. at about 50°, being evidently a continuation of the Grace Darling. It is 10 in. wide, of highly crystalline white quartz, with the spaces between the crystals filled up with decomposed pyrites. The hanging-wall is of greywacke, and the foot-wall of a hard, white elvan—probably a dyke. The reef was worked opencast, at first, and then from 3 shafts sunk to the dip, the deepest about 25 ft. At this depth, the reef is said to have split up into leaders. Only one crushing was taken out (from the opencast workings). It gave ½ oz. to the ton. The gold from the Glengarry had the highest Mint value of reef-gold on the field—viz. 3*l.* 9*s.* per oz. A shaft was sunk about 15 ft deep, between the Glengarry workings and the gully to the N.W., but the reef was not found. The country is dark-grey tourmaline-porphyry, with some greywacke.

Grace Darling reef is by far the longest continuously-worked reef on the field. Including the Glengarry, it extends for 420 yd., in a line running E. 38° S., to E. 15° S. The prospecting claim was taken up very shortly after the Hibernia. The "blow" is visible on the Grant road, and in two shallow shafts to the W. It is about 18 in. wide, and leads to the N.E. at about 40°. The hanging-wall shows débris of fine-grained tourmaline-porphyry. The quartz is white, but well honeycombed (from the decomposition of pyrites), brown on joints and faces, and with decomposed pyrites in spaces between the crystals. The first crushing, of about 100 tons, from the surface of the reef, gave 1 oz. 15 dwt. of gold to the ton. The prospectors sank 2 deep shafts: the shallower was about 40 ft. vertical; the deeper, on which a horse-whim was erected, was 45 ft. vertical; the reef was not reached at this depth. In the bottom of this shaft, the water-level was reached. About the same time, there was a rumour that King's machine was going to leave the field. The prospectors, to be in time, drove back and caught the reef at the 45-ft. level, and took out 30 tons of brownstone, which crushed 1½ oz. to the ton. The white stone was richer in gold in this claim than was usual on the field. The country is coarse-grained tourmaline-porphyry.

No. 1 Claim S. has 2 deep shafts (about 35 ft.) and 4 shallow ones on the underlie from the outcrop. The reef is a little over 8 in. wide. It is a highly crystalline, yellow, ochreous stone, the crystals being stained yellow on the faces. Some cavities are pretty rich in brownstone. The owners of the claim had only one crushing, which gave about 1 oz. to the ton.

No. 2 Claim S. had 3 shafts, two sunk vertically to the reef (about 25 ft.), and one on the underlie from the outcrop. The stone is in blocks of 9 or 10 in. in thickness, and this appears to have been the size of the reef. It is a very white quartz, with crystalline cavities, and joints stained red and yellow with iron oxide. The country is fine-grained tourmaline-porphyry. The only crushing from this claim realized 3 or 4 dwt. to the ton.

The owners of No. 1 Claim N. sank 2 shafts on the left bank of Green Creek. Both caught the reef, the upper at 25 ft., and the lower at 10 ft. from the surface. On following the reef to the underlie, the water was found to interfere seriously with the work. One crushing (1 oz. 5 dwt. to the ton) was taken out of the upper shaft. The quartz is white, with some crystalline cavities filled with ochreous decomposed brownstone, and coated on joints with yellow ochre. The country is fine-grained tourmaline-porphyry, with some greywacke.

In No. 2 Claim N., the reef is seen in an underlie shaft on the outcrop. It is a very white quartz, like that in No. 1 N., but the specimens visible appear to be rather richer in decomposed pyrites. A crushing from this shaft gave 1 oz. 2 dwt. of gold to the ton. Two shafts, 20 ft. deep, show coarsely crystalline tourmaline-porphyry, with specks of pyrites throughout. These shafts did not reach the reef.

Near the head of the W. branch of Green Creek are 3 small openings, apparently on an insignificant leader. Some very small fragments of quartz are all that is to be seen. Some 500 yd. farther N.W. are 3 shallow shafts, which have followed something on an underlie to the S.E. A little quartz has been taken out. It is crystalline, and brown on joints, although very white inside. On a hill-top, 300 yd. S.W. of the last-mentioned shafts, and 600 yd. N.W. of No. 2 North Grace Darling, is a shaft in which a 3-in. quartz vein has been followed down from the outcrop. It strikes W. 1° N., and dips N. 1° E. at 65°. This is believed to be the place from which "Scotch Elliott" crushed 5 tons, which gave 3 oz. to the ton. Two small shafts sunk higher up the hill have failed to catch this (or any) reef.

Leaving the principal line of reefs, a few are found on the summits of the Normanby range. One of these crosses the Grant road just on the W. side of the pass which carries the road over into the Grant valley. It runs N. 21° W., and dips E. 21° N., a spring rising on its upper side forming the head of Green Creek. It has been opened out a little in a hole on the S.E. side of the road, and appears unusually rich in brownstone for this locality. From its appearance, it would be considered a very promising reef, but it yielded no "colours" to the prospectors. With a view to testing whether any gold had been washed from the surface, Jack had the bottom of the gully tried at an angle where much of the wash from the reef must certainly have been caught, but with a purely negative result. On a long summit of the range, N. of the Marquis and E. of the Glengarry, a large "blow" of quartz occurs. Its course is E. 36° S., and its underlie N. 36° E. It is 6 ft. wide at the S.E. end, and the quartz is white with joints stained with peroxide of iron. To the N.W., the reef not only narrows, but becomes more mixed with decomposed pyrites. Three shallow holes have been sunk on the outcrop. The country is greywacke, dipping at a high angle to N.E. N. of the Welcome and E. of the Marquis, another reef is seen on a summit in the range. It runs E. 31° N., and underlies S. 31° E. at 85°. It is white and uncrystallized, and averages 1 ft. in thickness. The country is fine-grained pyritous tourmaline-porphyry.

On the ridge between the Welcome mines and the head of Spring Creek, is a quartz reef 3 or 4 ft. wide, bearing N. 6° E. and underlying E. 6° S. As a rule, the stone is white and vitreous, but a fair-sized heap (5 or 6 tons) of picked stone lies at the bank. There are two openings on the outcrop, and one vertical shaft. The latter has tumbled in, but does not seem to have reached the reef, although only about 5 yd. distant from the outcrop. The underlie appears to be steep. The quartz in the heap is coloured yellow and brown with iron oxide on surfaces and joints, and contains (rather rare) blotches of copper- and iron-pyrites, and stains of green carbonate of copper, besides frequent "nests" of chlorite. It is full of cavities, whose interior is lined with quartz crystals, much browned, as if masses of iron-ore had weathered out. The walls are of decomposed tourmaline-porphyry. Fine "colours" and some thready gold were obtained.

Albion reef occurs on the gully of the same name, falling into the W. fork of the Grant. It runs W. 39° N., and underlies N. 39° E. at about 55°. It varies from 2 to 6 ft. wide, bulging out to 10 ft. in places. It is generally a very compact white vitreous quartz, with brown stains only on the joints. In places it is "rubbly," or intersected by frequent joints, all iron-stained. It is rarely crystalline. The country is greywacke and shale. The mine was taken up by Long Jim and others about two months after they took up the Hibernia; ½ ton of stone, sent to Sydney shortly after the opening of the reef, gave gold at the rate of 2 oz. to the ton. They had afterwards a crushing (at King's machine) from the top of the reef, which gave 1 oz. 5 dwt. to the ton. The Albion Co. next took up the claim in 1875. They made a drive 50 or 60 yd. in length into the hill, and worked the reef up to daylight (about 80 ft. on the underlie) and down the underlie for about 15 ft. The company had a machine on the Grant, about ½ mile from the mine, and had several crushings, the best giving 11 dwt., and the worst 2½ dwt., to the ton. Their machine was afterwards removed to Marengo. A little below the mine, the bedding of the rock is seen—a rare occurrence in this neighbourhood. It is quartzose greywacke and chlorite-slate, nearly on end, but with a slight dip N.E.

Venture reef lies about ½ mile S.S.E. of the Albion. It runs E. 26° S. with a very slight hade to N. 26° E. The mine was taken up by Fred. Burstall about the same time as the Albion. He took 25 tons of brownstone from the top of the 70-ft. shaft, which crushed 1 oz. 18 dwt. to the ton at King's machine. He sank the 70-ft. shaft to the depth of about 40 ft. The rest of the work was done by the Venture Co., who took up the claim prior to their operations at the Marquis. They found water (not heavy) at the depth of 65 ft. in the 70-ft. shaft. Their first crushing was 70 tons at their own machine, beside the mine. It yielded 11 dwt. to the ton. Only 11 tons more were taken out, from the bottom of the 25-ft. shaft. This parcel gave a somewhat better result, viz. 18 dwt. to the ton. In the 25-ft. shaft, the reef was only 6 in. wide; in the 50-ft. shaft, it averaged 18 in.; and in the 70-ft. shaft, 2 ft. Below the 50-ft. level, the stone was very white, with yellow coatings. A good deal is now lying at grass. It shows specks of fine cubical iron-pyrites. The country at the mouth of the 50-ft. shaft is fine-grained greywacke and shale, and at the mouth of the 25-ft. shaft, fine-grained tourmaline-porphyry.

Enterprise reef occurs on a spur on the right bank of Enterprise Gully. It runs E. 29° N., and underlies at 80° to N. 29° W. The mine was worked about 1876–7. The reef is 6 to 12 in. wide; it was worked at two levels on the hillside. In the upper level, the reef is seen to thin downwards in an opencast. It is a white vitreous quartz, with cavities faced with very large crystals, the interstices filled up with decomposed pyrites, and with some faces coated with copper-pyrites. About 8 tons of quartz lie at bank here, but none was crushed from this level. The walls are of decomposed granite. At the lower level, the prospectors drove into the hill, and also went down on the reef for 10 or 12 ft. Where the reef has been left, it has pinched out to 2 or 3 in., but it must have been 10 in. wide in places, as evinced by the size of the blocks taken out. About 4 tons from this level and 3 from a lower level (at the edge of the gully) were crushed at the Venture Co.'s machine before its removal from the Grant valley, and gave 8 dwt. gold to the ton. Two tons of this stuff are left at bank. It is much whiter than the stone from the upper levels (with a little blue carbonate of copper), but it is said to have given much better prospects. In the Enterprise Creek, below the reef, one ½-oz. and one 14-dwt. nugget were found, besides coarse "colours." Above the reef, no gold could be obtained.

Just-in-Time reef lies between Hungry Gully and Oakey Creek, S. of the Bowen road. It runs W. 25° N., and underlies N. 25° E. at about 45°. The prospecting claim was taken up by John Smith and others some 6 months after the Hibernia. They took out 25 tons of brownstone, which crushed 1 oz. 8 dwt. to the ton; the next crushing, of 40 tons, gave 1 oz. 12 dwt.; the last, 1 oz. 7 dwt. The reef averages 5 in. in width, but thins away to 2 and bulges out to 9 in places. The prospectors went down about 70 ft. on the underlie. They had not reached the water-level even at that depth. The claim paid while King's machine remained on the field. The gold was getting a little rougher in the deeper workings, and the stone rather more stained with carbonate of copper. The Mint value of the gold was 3*l.* 7*s.* What little is left of the stone is of the usual character, essentially white and vitreous, but with frequent crystalline cavities filled with decomposed pyrites. The country is a somewhat coarse-grained pyritous tourmaline-porphyry. It was soft and easily worked in the prospecting claim, requiring little blasting. In No. 1 Claim, the reef is narrow, as in the prospecting claim. The claim was first held by the prospectors, and afterwards by King, who put two men on it. The reef was sunk 45 ft. on the underlie, and cut at the depth of 40 ft. in a vertical shaft. Two crushings of the brownstone yielded, the first 1 oz. 8 dwt., and the second 1 oz. 5 dwt. of gold to the ton. At the bottom of the vertical shaft, the mundic began to come in. A specimen of this mundic (free from quartz) assayed 6 oz. 4 dwt. 3 gr. of gold, and 5 oz. 11 dwt. 1 gr. of silver, to the ton. On No. 2 Claim, a shaft, 20 ft. deep, was sunk, but did not cut the reef. A trench failed to discover the outcrop.

On the gully S. of the Just-in-Time workings are 5 shafts, and a line of opencast workings on a reef running W. 11° N., and heading N. 11° E. at about 70°. A shift at the junction of this reef with the Just-in-Time may explain why the latter was not found in No. 2 Claim. The reef is 6 in. to 1 ft. wide, and shows a mixture of brownstone and very fine white quartz. The quartz and gangue of the reef are often a good deal stained with carbonate of copper. The country is tourmaline-porphyry. This reef was worked simultaneously with the Just-in-Time. It had two crushings, the first (20 tons) giving 1 oz. 5 dwt. of gold to the ton, and the second (30 tons) 1 oz. 7 dwt.

A reef running W. 16° N., and underlying to N. 16° E. at 65°, occurs between the Just-in-Time workings and the Bowen road. At the E. end, the reef is 2 to 6 in. wide. It was sometimes 12 in. It is a white crystalline quartz with yellow joints. The country is tourmaline-porphyry. This mine was worked simultaneously with the Just-in-Time. The workings reached a depth of 30 ft. in the underlie. Only one crushing (30 tons) was taken out; it gave 15 dwt. to the ton. The gold was rough for this field, the particles being visible to the naked eye. One speck is said to have weighed 3 dwt.

Lardyda reef lies N.W. of the Just-in-Time, on the E. side of the Bowen road. Its direction is W. 26° N., and its hade to N. 26° E. at about 50°. The mine was worked at the same time as the Just-in-Time. The quartz sometimes bulged out to 6 or 8 in. in width, and sometimes was only represented by a "mullock vein" (gangue without reef). The workings only reached a depth of 30 ft.; 11 tons crushed at King's machine yielded 17 dwt. to the ton. The country is fine-grained tourmaline-porphyry.

A reef occurs between Hungry Gully and Green Creek, on the right bank of Green Creek, opposite Campbell's stockyard. It runs W. 36° N., and hades to N. 36° E.; 25 tons of brownstone crushed at King's machine yielded gold at the rate of 1 oz. 2 dwt. to the ton. The country is tourmaline-porphyry and greywacke.

In Campbell's Paddock, near the slip-panel, S.E. of the stockyard, two shallow shafts have been sunk on a small leader running W. 26° N., and hading to N. 26° E. at 60°. The country is fine-grained pyritous greywacke. At the head of the gully, between the garden and stockyard, are 3 or 4 shallow openings on a quartz leader, which runs N. 39° W. and hades to E. 39° N. The country is tourmaline-porphyry. A small quantity of brownstone was raised from this leader; 3 tons crushed at King's machine gave 2 oz. to the ton. The leader was found to pinch out. Near this reef, just outside the paddock, two shafts were sunk on a small leader of poor white stone, striking N. 39° W., and hading at 45° to E. 39° N.

Wild Scotsman reef occurs on the E. slope of Mount High, with a course S. 34° W., and hades W. 34° N. at 70°. At the S.E. end, it is represented by a 10-in. granite vein (in fine-grained tourmaline-porphyry country), which soon pinches out (as may be seen in the opencast workings), and gives place to a 3-in. leader of quartz with brownstone. Some brownstone from the N.E. end of the reef crushed for about 1 oz. to the ton at King's machine. The reef was too thin to pay. Between the opencast working and the upper gully, is a vertical shaft which catches the reef at a depth of 25 ft. and follows it on the underlie for a short distance. As seen in the upper gully, the reef or leader is only about 1 in. wide. The shaft above the upper gully is 15 ft. vertical, and follows down the underlie a few feet. From this shaft, only a little quartz has been raised, similar to that of the 1-in. leader in the gully.

Perseverance reef occurs on the E. side of the Bowen road, between two of the heads of Oakey Creek, nearly in a line with the Wild Scotsman; it runs W. 21° S., and hades to N. 21° W. at about 65°. It has been worked opencast for the whole length of the prospecting claim, and two deep shafts have also been sunk. The reef was "bulgy," like the Lardyda, sometimes pinching out altogether. A little of the stone lying about is white, with yellow stains on joints, and has come apparently from a narrow reef. Only one crushing of 35 tons was taken out; it yielded, at King's machine, gold at the rate of 1 oz. 5 dwt. to the ton. The country is fine-grained pyritous tourmaline-porphyry and greywacke. On the crest of the Normanby range, between Mount Flattop and Mount High, is a small quartz reef dipping at a low angle to the W. The quartz is white and highly crystalline.

The summit of Mount Flattop is seamed with reefs running from N. 11° E. to E. 29° N., and all underlying to the W. or N.W. At the W. end of the hill, a 1-ft. reef of fine-looking, shivery, honeycombed, red quartz, running N. 11° E., and hading to W. 11° N. at 80°, has been worked in a surface drive. It splits into two leaders at the N. end of the drive. E. of this are two leaders of brownish quartz, 1 to 2 in. wide, running N. 26° E., and hading at 80° to W. 26° N. Still farther E. (up hill) is a short drive on three small leaders of promising reddish shivery quartz, with gangue of decomposed granite between. They run N. 26° E., and underlie at 80° to W. 26° N. Higher up the hill, a short drive has been made on two leaders, 3 ft. apart. The lower is 8 in. wide—a fine-looking honeycombed quartz, with cavities filled with red decomposed pyrites. The quartz of the upper leader (3 in. wide) is white and compact. They run E. 39° N., and underlie to N. 39° W. at 80°. Some 50 ft. higher up the hill, is a short drive in a 4- to 8-in. leader of white quartz, with small cavities filled with decomposed pyrites; it runs E. 24° N., and underlies at 80° to N. 24° W. Within the next 100 yd. up the hill, at least half-a-dozen thin leaders, parallel to the last, have been worked opencast or in shallow drives. Near the E. end of the hill-top is a reef, bearing E. 29° N., and underlying to N. 29° W. at 65°. It is 8 or 9 in. wide, of white crystalline quartz. The country is granite. The stone from some of the Flattop reefs ought to be pretty rich. The opportunity for distinguishing between the payable and non-payable leaders was, however, lost by crushing them all together. It gave 11 dwt. to the ton. A tunnel in a N.W. direction through the mountain would probably lead to the discovery of several payable mundic reefs.

On the W. side of the Bowen road, N. of the Gap, through the Normanby range, a little leader, running W. 5° S., and hading to N. 5° W., was followed a few feet in an underlie shaft. A vertical shaft was also sunk on the underlie side, but it does not appear to have reached the leader. The work was done about 6 months after the opening of the Hibernia. It is believed that no crushings were taken out, unless it might be that the stone was mixed up with that from the Eureka reef. About ¼ mile N. is a reef 3 or 4 in. wide, which was taken up by Macartney about the same time as the last. It was worked opencast, except towards the gully, where it was followed down the underlie to the depth of 25 or 30 ft. It crushed at King's machine at the rate of 3 oz. and a few dwt. to the ton. The country is tourmaline-porphyry.

Eureka reef, situated N.W. of Mount High, between two of the heads of the Dart, was opened out simultaneously with the Just-in-Time. It runs W. 24° S., and is almost vertical. The reef is about 3 ft. wide, the quartz shivery and jointed ("rubbly"), and split up by courses of gangue. The joints of the quartz are generally coated with yellow, and sometimes stained with blue carbonate of copper. Large quartz crystals are rare. There are frequent cavities filled up with good-looking brownstone. The appearance of the stone, indeed, would warrant a higher estimate of its value than the crushings justified. The first gave 11 dwt., the second, 13 dwt., and the last, 9 dwt. of gold to the ton. The Mint value of the gold from the first crushing was only *2l. 6s.* per oz. The deepest shaft is 40 ft. The country is greywacke, stained in the neighbourhood of the reef with carbonate of copper.

The general character of the reef-gold from Normanby is said to have been very fine, as a rule, occurring in specks invisible to the naked eye. Alluvial gold from the field is, on the other hand, generally coarser, up to about the size of a small pea. The banks buy it at *3l. 12s.* per oz. Specimens are only slightly water-worn, and have numerous minute cavities coated with red peroxide of iron. This appearance is no doubt due to the decomposition of the pyrites with which the gold was originally associated in the reefs. The difference in the characters of the reef- and alluvial gold have led some of the miners on the field to the belief, that the latter has been derived from other reefs than those which have been known and worked ; but, although the existence of reefs still unknown is in the highest degree probable, Jack sees no great necessity for this explanation. Gold so fine as that which is said to have been commonly obtained from the reefs would be distributed by the streams so widely as to render its collection unprofitable, while only the larger and heavier grains would be detained by natural obstacles in the beds of the creeks and gullies near the reefs. The alluvial gold is very partially distributed. Diggers sometimes work for months without seeing more than "colours," but occasionally drop on a payable patch. From all Jack can learn, he believes that the alluvial gold taken from Normanby has cost in labour a great deal more than its money value. The largest nugget he heard of weighed 2 oz.

A miner named Brown informed him that he had found a few dwt. of native gold-amalgam in Green Creek, just below the junction of Oakey Creek, in alluvial gravel.

Jack concludes by stating his opinion that Normanby ought to pay now. It will be answered, however, that it has been fairly tried, and has failed. This is not so true as it appears at first sight. The field lived for about 18 months, and was killed by the removal of the crushing-mill. It is quite true that the few hasty crushings taken out in that time did not in many cases repay the heavy preliminary outlays. The wonder is that they did in any case ; but some of the reefs paid fairly well. In a few of the mines the mundic level was attained, and as there was no machinery on the field for treating stone of this class, the workings were promptly abandoned. The unusually rich assays of the mundic from the Just-in-Time and Welcome reefs warrant the hope, that, at no distant date, Normanby may again rank among the busy centres of mining industry, and that the field will do well as a whole.

It might be impossible on the large scale to pick the mundic as clean as in the specimens assayed, or to extract the whole of the gold ; but there is a large margin, and half the quantity contained in the Just-in-Time and Welcome mundic would be a good return.

The metamorphic rock (tourmaline-porphyry), among which the Normanby reefs principally occur, is a somewhat unusual variety, and therefore few observed facts exist to guide in judging the success of reefing in such country. In all probability, the gold was precipitated simultaneously with the deposition of the original sedimentary rocks collected together and associated with the pyrites when the metamorphism took place, and finally aggregated in the reefs.

At present, the mining population is limited to 3 men, who live in the hope of "dropping upon a patch" of payable alluvial gold. Their perseverance deserves success.

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